



**CERTIFICACIÓN NÚMERO 23-24-068**

La que suscribe, Secretaria de la Junta Administrativa del Recinto Universitario de Mayagüez de la Universidad de Puerto Rico **CERTIFICA** que, en reunión ordinaria celebrada el jueves, 16 de noviembre de 2023, este organismo **APROBÓ** el **IMPACTO PRESUPUESTARIO DE LA PROPUESTA DE CREACIÓN DEL PROGRAMA GRADUADO EN INGENIERÍA EN SOFTWARE, DEL COLEGIO DE INGENIERÍA, DEL RECINTO UNIVERSITARIO DE MAYAGÜEZ.**

El informe forma parte de esta certificación.

Y para que así conste, expido y remito la presente certificación a las autoridades universitarias correspondientes bajo el Sello del Recinto Universitario de Mayagüez, de la Universidad de Puerto Rico.

En Mayagüez, Puerto Rico, a los diecisiete días del mes de noviembre del año dos mil veintitrés.

*Carmen A. Negrón Moure*  
**Carmen A. Negrón Moure**  
Secretaria



cnm

Anejo



Universidad de Puerto Rico  
Recinto Universitario de Mayagüez  
Oficina de Presupuesto




13 de noviembre de 2023

Dra. Nancy Vicente Velez  
Rectora Interina  
Presidenta de la Junta Administrativa  
Recinto Universitario de Mayagüez

**IMPACTO PRESUPUESTARIO – PROPUESTA DE CREACION DEL PROGRAMA  
GRADUADO EN INGENERIA EN SOFTWARE**

Se incluye análisis presupuestario del impacto de la creación del Programa Graduado en Ingeniería en Software.

Cordialmente,

  
Jeannette Y. Rosado Pérez  
Directora  
Oficina de Presupuesto

**IMPACTO PRESUPUESTARIO**  
**PROPUESTA DE CREACIÓN DEL PROGRAMA GRADUADO EN INGENIERÍA DE SOFTWARE**  
**COLEGIO DE INGENIERÍA**  
**RECINTO UNIVERSITARIO DE MAYAGÜEZ**

**I. TÍTULO Y GRADO A OTORGAR:**

Programa Graduado en Ingeniería de Software

**II. DESCRIPCIÓN:**

En reunión celebrada el 19 de septiembre de 2023 el Senado Académico aprobó la Certificación número 23-50 en la cual el Departamento de Ciencia e Ingeniería de Computación (CIIC), del Colegio de Ingeniería del Recinto Universitario de Mayagüez, propone la creación de un Programa Graduado en Ingeniería en Software. El programa propuesto consta de los siguientes grados académicos:

- a. Maestría en Ciencias en Ingeniería de Software (MS) (Plan I - Tesis) – 30 créditos, con duración de 4 semestres (2 años).
- b. Maestría en Ingeniería en Ingeniería de Software (ME) (Plan II - Proyecto y Plan III – Cursos optativos) – 30 créditos, con duración: 4 semestres (2 años)
- c. Doctorado en Filosofía en Ingeniería de Software (PhD) – 54 créditos, duración de 8 semestres (4 años)

**III. JUSTIFICACIÓN:**

La creación de programas graduados es fundamental para el desarrollo académico y de la Investigación en la Universidad de Puerto Rico y de Puerto Rico. El programa graduado propuesto por el Colegio de Ingeniería, responde a la oportunidad de continuar siendo pioneros en el campo de la Ingeniería de Software.

La oferta de programas académicos en Ingeniería de software es limitada en nuestro sistema de educación superior. El único programa subgraduado en Ingeniería de Software en todo Puerto Rico se ofrece en el Recinto de Mayagüez y no existe ningún programa graduado de maestría o doctorado en Ingeniería de Software en la isla. Esto limita el desarrollo de esta disciplina, pero también nos ofrece la oportunidad de continuar siendo líderes en este campo y ofrecer grados de maestría y doctorado en un área profesional de continuos cambios y rápido desarrollo por los cambios en tecnología.

El programa subgraduado en Ingeniería de software ofrece una base, pero el programa graduado busca profundizar y expandir las destrezas y conocimientos en el campo. El programa graduado abre las puertas de oportunidades a competir por fondos externos de investigación y desarrollo que actualmente no se tienen. También busca atraer a profesionales en el campo, que interesen continuar su crecimiento académico y mantenerse al día con las nuevas tecnologías.

Este programa cubre unas necesidades muy importantes para el desarrollo del país en el área de creación de software.

#### **IV. COSTO:**

Luego de analizar la propuesta y según expresado por el Decano de Ingeniería, Dr. Bienvenido Vélez, encontramos que:


- El Programa Graduado en Ingeniería en Software recibirá apoyo en las áreas Académicas y Administrativas del personal actual en el Departamento de Ciencias e Ingeniería de la Computación (CIIC) del Colegio de Ingeniería. Su funcionamiento estará integrado a las tareas operacionales de este Departamento.
- El Programa Graduado en Ingeniería de Software buscará la contribución de fondos externos que apoyen la investigación, compra de equipo, materiales, gastos de viaje y apoyo a estudiantes graduados.
- La expectativa es tener un promedio de 45 estudiantes matriculados en los programas de maestría y doctorado en Ingeniería de Software. Estos en adición a los que actualmente se atienden en el Doctorado que se ofrece en conjunto entre los Departamentos de Ciencia e Ingeniería de la Información y la Computación (CIIC) y el Departamento de Ciencias Matemáticas. Por lo que se espera atender un promedio de 60 estudiantes.
- Al concluir los Planes de Reclutamiento de los años fiscales 2023 y 2024 se completaría el personal docente necesario para apoyar el Programa Subgraduado actual y el Programa Graduado propuesto. Los costos actualizados de estos planes de reclutamiento, considerados en el presupuesto de cada año fiscal son los siguientes:

	PR - FY -23	PR - FY -24	TOTAL
<b>Salarios</b>			
Catedratico Auxiliar	70,548.00		
Catedratico Auxiliar	70,548.00		
Catedratico Auxiliar		\$ 70,548.00	
Catedratico Auxiliar		70,548.00	
<b>Total Salarios</b>	<b>\$ 141,096</b>	<b>\$ 141,096</b>	<b>\$ 282,192</b>
<b>Beneficios</b>			
Aportaciones Federales y Estatales	\$ 12,769	\$ 12,769	
Aportacion Plan Retiro - PCD	\$ 5,997	\$ 5,997	
Plan Médico	\$ 15,821	\$ 15,821	
Bono Navidad con aport. Patronales	\$ 1,309	\$ 1,309	
Fondos Semillas	\$ 16,000	\$ 16,000	
<b>Total Beneficios</b>	<b>\$ 51,896</b>	<b>\$ 51,896</b>	<b>\$ 103,791</b>
<b>Asign. Presup. adicional en los últimos dos años</b>	<b>\$ 192,992</b>	<b>\$ 192,992</b>	<b>\$ 385,983</b>

## V. CONCLUSIÓN:

Se proyecta que el establecer el Programa Graduado en Ingeniería en Software no genere costos adicionales para la Institución. El apoyo administrativo y de consejería académica se realizará con el personal actual en el Departamento de Ciencia e Ingeniería de Computación. Según indica la propuesta, las necesidades que puedan surgir para materiales, equipos, viajes y ayudantías pueden ser apoyadas por fondos externos identificados y nuevos fondos que puedan obtenerse.

La Oficina del Presupuesto recomienda apoyar esta propuesta ya que es una ventana de oportunidad y crecimiento en un campo en el que somos líderes como Institución. Una propuesta que se proyecta trabajar con los recursos humanos, físicos y económicos disponibles en este momento sin inversiones adicionales, lo que demuestra efectividad en el uso de los recursos.

  
 Jeannette Y. Rosado Pérez  
 Directora  
 Oficina de Presupuesto  
 Recinto Universitario de Mayagüez

20 de octubre de 2023

Sra. Jeannette Rosado Pérez  
Directora  
Oficina de Presupuesto  
Recinto Universitario de Mayagüez  
Universidad de Puerto Rico

**RE: Análisis Presupuestario de la Propuesta para Establecer un Programa Graduado en Ingeniería de Software en el Recinto Universitario de Mayagüez de la UPR**

Estimada señora Directora:

¡Reciba un cordial saludo! Por este medio presento ante usted la información necesaria para que se pueda completar el análisis presupuestario de la propuesta en epígrafe, y se pueda sustentar que la misma no requiere asignaciones presupuestarias adicionales al Departamento de Ciencia e Ingeniería de Computación (CIIC) del RUM. Se adjunta a esta comunicación un documento titulado "*Graduate Program in Software Engineering at the University of Puerto Rico, Mayagüez: Budget Analysis*". Dicho documento es un extracto de las secciones en la propuesta que tocan los temas administrativos y presupuestarios.

A continuación, se atienden varios temas:


1. Administración – El Programa Graduado en Ingeniería de Software (INSO) será administrado por el Departamento de Ciencia e Ingeniería de Computación (CIIC) y su funcionamiento será integrado a las tareas operacionales del Departamento. Los asuntos académicos del Programa serán atendidos por el Comité Graduado del Programa, a tenor con la certificación SA 09-09 del RUM. No se otorgarán diferenciales, o compensaciones adicionales a los miembros de dicho comité ya que esta labor está contemplada en la tarea regular docente (ver Anejo A, sección 3).
2. Matricula Graduada – Se estima que el Programa Graduado INSO tendrá una matrícula de 45 estudiantes al año, distribuidos de la siguiente manera: 20 estudiantes de doctorado y 25 estudiantes de maestría (ver Anejo A, sección 1). A este total se suman los 10-15 estudiantes que normalmente tiene el programa PhD en CISE, el cual el Departamento CIIC administra junto con el Departamento de Ciencias Matemáticas. El total de estudiantes graduados sería de aproximadamente 60 estudiantes al año.
3. Recursos Humanos y Físicos – El programa será apoyado con las facilidades físicas y computacionales existentes (Ver Anejo A, sección 5).

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4. Personal Administrativo – El programa será apoyado directamente por el Director Asociado (Dr. Emmanuel Arzuaga) y por la Asistente Administrativo del Departamento CIIC (Sra. Lymari Arzola). Apoyo adicional en temas clericales será ofrecido por la Secretaria Administrativa de CIIC (Sra. Zoé Valle), quien regresó a su puesto. En este momento, no se solicita contratar nuevo personal de consejería académica, ya que, por el volumen de estudiantes y la naturaleza graduada del programa, esta labor la realizará el Director Asociado y los profesores que figuren como consejeros graduados de los estudiantes.
5. Facultad – El Departamento CIIC cuenta con nueve (9) profesores a tiempo completo, tres (3) contrataciones temporeras a tarea parcial, y dos (2) convocatorias activas en el rango de catedrático auxiliar. Para apoyar el programa propuesto con un cupo máximo sostenido de 60 estudiantes graduados, se requieren 1.25 FTE (Faculty Time Equivalent). Estos recursos ya fueron incluidos dentro de los planes de reclutamiento aprobados por la Presidencia de la UPR, donde se autorizaron tres (3 FTE) plazas docentes como compromiso institucional para apoyar el Proyecto *NSF Center for the Advancement of Wearable Technologies (CAWT)*. Se estima que estos tres profesores mantendrán un 50% (1.5 FTE) de su carga académica para realizar investigaciones y el restante 50% (1.5 FTE) para la enseñanza. Por ende, la contratación de estos tres profesores superaría los 1.25 FTE que requeriría el nuevo programa. Ya se reclutó un profesor para la primera de estas plazas y tenemos una convocatoria abierta para reclutar las otras dos plazas. Esperamos que estos dos profesores comiencen en enero de 2024 en el RUM. (Ver Anejo A, secciones 2 y 4.2).
6. Ayudantías Graduadas– Las ayudantías de investigación serán sufragadas con fondos externos. Las ayudantías de cátedra están atadas a: 1) dictar los cursos de laboratorios de los programas subgraduados en Ingeniería de Software y Ciencia e Ingeniería de Computación, y 2) labores de corrector en mega-secciones de cursos INSO o CIIC. No se propone otorgar ninguna ayudantía que no esté atada a una fuente de repago (ver Anejo A, sección 4.3). El nuevo programa no añade carga de cursos subgraduados de laboratorio por lo que no se requiere asignación presupuestaria adicional.
7. Ingresos Adicionales – la Facultad del Departamento CIIC está activa en la investigación, y han obtenido \$2,694 en fondos externos para el Recinto (ver Anejo A, sección 4.3).

Por lo antes expuesto, el Programa Graduado INSO propuesto no requiere asignación presupuestaria adicional a la ya asignada al Departamento de Ciencia e Ingeniería de Computación (CIIC) del RUM.

Cordialmente,



Dr. Bienvenido Vélez  
Decano  
Colegio de Ingeniería

Antes, ahora y siempre... ¡Colegio!

# Graduate Program in Software Engineering at the University of Puerto Rico, Mayagüez

## Budget Analysis

### 1 Admission Projections

Our expectation for the Graduate Program in Software Engineering is to sustain an average enrollment of at least forty-five (45) students per year, distributed as follows: a) 20 PhD students, and b) 25 MS/ME students. This is consistent with current enrollment figures in Engineering Graduate Programs at UPRM<sup>1</sup>, and is comparatively much smaller than undergraduate programs.

### 2 Department Faculty

The following table lists the current faculty, their fields of research and the courses they may teach in the proposed SWE Graduate Program.

*Table 1: Graduate Faculty for the SWE Program*

Name	Highest Degree	Fields of Specialty	Courses
Emmanuel Arzuaga	PhD	Virtualization, Cloud Computing, Machine Learning	INSO 6007, INSO 6015, INSO 6050, INSO 6998, INSO 6997, INSO 8995, INSO 8996, INSO 8997, INSO 8999
Kejie Lu	PhD	Networking	INSO 6007, INSO 6070, INSO 6998, INSO 6997, INSO 8995, INSO 8996, INSO 8997, INSO 8999
Wilson Rivera	PhD	High Performance Computing, Big Data Analytics	INSO 6007, INSO 6010, INSO 6015, INSO 6998, INSO 6997, INSO 8995, INSO 8996, INSO 8997, INSO 8999
Pedro Rivera	PhD	Algorithms	INSO 6030, INSO 6998, INSO 6997, INSO 8995, INSO 8997, INSO 8999
Manuel Rodríguez	PhD	Database Systems, Big Data Analytics, Data Engineering	INSO 6006, INSO 6030, INSO 6040, INSO 6998, INSO 6997, INSO 8995,

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<sup>1</sup> Source: OPIMI Dashboards <https://oiip.uprm.edu/dashboards/>



			INSO 8996, INSO 8997, INSO 8999
Marko Schutz	PhD	Software Engineering, Algorithms	INSO 6005, INSO 6010, INSO 6998, INSO 6997, INSO 8995, INSO 8997, INSO 8999
Heidy Sierra	PhD	Computational Optics, Deep Learning	INSO 6015, INSO 6998, INSO 6997, INSO 8995, INSO 8996, INSO 8997, INSO 8999
Bienvenido Vélez	PhD	Software Quality, Software Engineering, Programming Language and Compilers	INSO 6005, INSO 6006, INSO 6030, INSO 6998, INSO 6997, INSO 8999
Juan Patarroyo (new hire 2022-2023)	PhD	Machine Learning, Software Engineering	INSO 6005, INSO 6015, INSO 6040, INSO 6998, INSO 6997, INSO 8995, INSO 8996, INSO 8997, INSO 8999
New Faculty Hire #2 for 2023-2024	PhD	Data Streaming, Sensor Networks	INSO 6006, INSO 6040, INSO 6070, INSO 6998, INSO 6997, INSO 8996, INSO 8997, INSO 8999
New Faculty Hire #3 for 2023-2024	PhD	Data Science & Analytics, Software Engineering	INSO 6007, INSO 6006, INSO 6040, INSO 6998, INSO 6997, INSO 8995, INSO 8996, INSO 8997, INSO 8999

### 3 Administration of the Program

The Department of Computer Science and Engineering at UPRM will administer the Graduate Program in Software Engineering (SWE). The administrative structure, regulations, and decision-making instances for the SWE Program are those specified in sections C, D and E of Certification 09-09 of the Academic Senate of the University of Puerto Rico at Mayaguez, as amended in March 17<sup>th</sup>, 2015 by Certification 15-21.

#### 3.1 Departmental Leadership

The CSE Department is led by a Departmental Director which serves as its executive official, and supervisor of all faculty and staff members. The Director is assisted by an Associate Director, which serves the role of deputy director and second in command. Currently, the

position of Departmental Director is held by Dr. Pedro I. Rivera Vega, and the Associated Director is Dr. Emmanuel Arzuaga Cruz.

### **3.2 Graduate Committee**

The implementation of Section C of Certification 09-09 of the UPRM Academic Senate will be done with the **Software Engineering Graduate Committee**. The SWE Graduate Committee will handle all academic and administrative matters of the program, with clerical support provided by the staff of the CSE Department. The SWE Graduate Committee shall consist of at least three (3) members, all of which must be faculty members of the CSE Department. Each member will serve a three (3) year term, and can be re-elected once. Election of members shall happen in a duly convened CSE Departmental meeting. In order to guarantee stability and experience within the SWE Graduate Committee, the first time the SWE Committee is elected, two of its members will serve a two-year term, while the third one will serve a three-year term. This choice of terms will be done at random by the Chairman of the CSE Department. This arrangement will help ensure that not all committee members are replaced at the same time, and there will always be an experienced member in the committee. The CSE Department might change the number of members in the SWE Graduate Committee. This can be done by direct vote of the faculty members in a duly convened Departmental Meeting. Changes will be informed to the Dean of Engineering, the Director of Graduate Studies, and the UPRM Dean of Academic Affairs.

The members of the SWE Graduate Committee will choose one of its members as the President of the Committee. The SWE Graduate Committee shall establish a set of regular meetings throughout the semester to attend all businesses related with the SWE Graduate Program. All matters related with admissions, special exams, courses, or any other the issue related with the program shall be communicated by the President of the SWE Graduate Committee to the CSE Associate Director.

### **3.3 Staff Support**

Direct support for the program and students will be delivered by means of our existing Administrative Assistant position, currently held by Mrs. Lymari Arzola. This position also supports other programs of the CSE Department, including the PhD CISE Program. Currently, our graduate programs do not have a dedicated Academic Affairs Officer, as undergraduate programs do. This activity is carried out by CSE Associate Director. Other clerical personnel in the department includes:

- a) Mrs. Sarah Ferrer – Administrative Official
- b) Mrs. Zoe Valle – Administrative Secretary

## **4 Budget Plan**

### **4.1 Staff and Administration Costs**

At this moment, no extra funds are requested for administration; all administration costs of the program will be covered with the recurrent budget of the Department of Computer Science and Engineering (CSE). Direct support for the program will be delivered by means of our existing

staff, in particular our Administrative Assistant position, currently held by Mrs. Lymari Arzola. This position also supports the CISE PhD Program.

The implementation of Section C of Certification 09-09 of the UPRM Academic Senate will be done with the **Software Engineering Graduate Committee**. The SWE Graduate Committee will handle all academic and administrative matters of the program, with clerical support provided by the staff of the CSE Department. The SWE Graduate Committee shall consist of at least three (3) members, all of which must be faculty members of the CSE Department. Participation in this Committee will be counted as part of the regular committee duties of the faculty members. No additional compensations for this work is budgeted.

## 4.2 Faculty Costs

The SWE Graduate Program requires the courses shown in Table 2 and Table 3 to be taught each year:

*Table 2: Maximum Credits Required During Fall Terms*

Course Code	Name	Credits
INSO 6005	Software Engineering Principles	3
INSO 6006	Database Systems Engineering	3
INSO 8996	Doctoral Research Seminar	3
INSO 6---	Elective Course in SWE	3
INSO 6---	Elective Course in SWE	3
<b>Total Credits Required</b>		<b>15</b>

*Table 3: Maximum Credits Required During Spring Terms*

Course Code	Name	Credits
INSO 6007	Secure Software Engineering	3
INSO 8995	Advanced Topics	3
INSO 6---	Elective Course in SWE	3
INSO 6---	Elective Course in SWE	3
INSO 6---	Elective Course in SWE	3
<b>Total Credits Required</b>		<b>15</b>

As we can see from Table 2 and Table 3, running the SWE Graduate Program requires **15 credits** in regular graduate courses per semester, whether it is the Fall semester, or the Spring semester. This number is a worst-case scenario, as it might be the case that some of the existing 5000-level courses currently being offered by the CSE Department are taken by the graduate students. Nonetheless, we shall continue using this 15-credit figure for the remainder of this presentation. In this analysis, we do not include the Master's thesis, Master's projects, or Doctoral dissertation courses because these courses are normally part of the research release time, or research buy-out time that CSE faculty members are assigned in order to execute their research projects and supervise the graduate students in those projects.

With the 15-credit per semester figure in hand, we can map this number to the Faculty Time Equivalent (FTE) figure that indicates the number of faculty members needed to run the program. The regular teaching load per faculty member at UPRM is 12 credits per semester, and this figure is equivalent to one (1) FTE. Hence, the SWE Graduate Program requires 1.25 FTE, in steady state, to cover all the courses in the program. There is a simple option to cover this FTE need:

- Hire three assistant professors that are 50% devoted to teaching and 50% devoted to research. These new hires represent 18 credits in teaching load and can cover all 15 credits in SWE Graduate courses. The remaining 3 credits in teaching load can be used to support other programs as needed.

**The CSE Department can successfully accommodate and implement this option within its current faculty hiring plan and available faculty positions.** During the Fall of 2023, the CSE Department hired Dr. Juan Patarroyo to a faculty position associated with the NSF Center for the Advancement of Wearable Technologies (CAWT). The CSE Department is a key partner in this research center, with the following participants:

1. Dr. Manuel Rodriguez-Martinez – Co-leader and researcher with the Interdisciplinary Research Group (IRG 3).
2. Dr. Emmanuel Arzuaga-Cruz – Researcher with the Interdisciplinary Research Group (IRG 3).
3. Dr. Heidy Sierra-Gil – Researcher with the Interdisciplinary Research Group (IRG 3), and liaison between IRG3 and IRG1.
4. Dr. Juan Patarroyo– Researcher with the Interdisciplinary Research Group (IRG 3).

We currently have two additional open faculty positions that can be hired to start on January 2024. These positions are already budgeted. As part of the *Programmatic Terms and Conditions* between and NSF and UPR, the President of UPR **authorized** these **two new** additional hires in the CSE Department to support the research efforts of the CAWT project. Thus, a total of three faculty members are available to support the CAWT project. These faculty members could initially focus their faculty teaching efforts on teaching the SWE Graduate Efforts. Alternatively, the new hires can balance their load with graduate and undergraduate courses, while existing professors can also teach graduate and undergraduate courses. **The new FTE available with these hires provide the means to cover the teaching load required by the SWE Graduate Program.**

*Table 4: CSE Faculty Hiring Plan for CAWT Project*

Faculty Hire	Recruitment Year	Start Year	Rank	Salary	Salary + Benefits
Faculty #1	2023-2024	2024	Assistant Professor	\$70,548.00	\$ 95,980.15

Faculty #2	2023-2024	2024	Assistant Professor	\$70,548.00	\$ 95,980.15
<b>Total Faculty Costs</b>					<b>\$ 191,960.30</b>

Table 4 shows the hiring schedule and costs for the two new CAWT faculty hires that count towards the 2023-2024 fiscal year budget. As we can see from the table, the SWE Graduate Programs **costs** \$191, 960.30 in new expenditures. This figure includes salary, health insurance, Christmas Bonus, and the other required fringe benefits (e.g., unemployment compensation). However, as we mentioned before, the President of UPR has committed to authorize these additional hires in the CSE Department to support the CAWT project. This is part of the 3% faculty hiring plan that the Puerto Rico Financial Oversight and Management Board (FOMB) (established under the PROMESA Federal Law) authorized for UPR. We launched the hiring search for the Faculty #1 under faculty announcement number 22-01. The link for the announcement can be found at:

<https://www.uprm.edu/empleos/2023/09/05/reapertura-convocatoria-22-01-catedratico-auxiliar-ciencia-e-ing-computacion-2023/>

Faculty #2 is also being hired and the link for the announcement 22-24 can be found at:

<https://www.uprm.edu/empleos/2023/09/05/22-24-reapertura-convocatoria-catedatico-auxiliar-ciencia-e-ingenieria-de-la-computacion-2023/>

### 4.3 Program Incomes and Graduate Assistantships

The major source of income for the program to offer graduate assistantships is *external*. Funds for research in CSE are available on a competitive basis from federal agencies. **Table 5** shows the funded projects of the faculty of the CSE Department over the past five years. As we can see from the table, the total of amount of funding is roughly \$2, 694, 000. These funds support researchers, equipment purchases, materials, travel expenses, and provide **assistantships** to graduate students. The SWE graduate program will also seek industry contributions.

The institution often provides programs with teaching assistants and graders to support teaching. However, this is primarily done with the larger class sections (>35 students). Also, courses that have a laboratory as part of it (for example: CIIC 4010, CIIC 4020, and CIIC 4050) are assigned TAs, which take care of one or two sections of laboratories. Each of those laboratory sections groups at most 30 students. These assistantships are funded from tuition and laboratory fees, thus are self-sustained.

As a result of laboratory teaching demands posed by courses in the baccalaureates in Computer Science and Engineering, and in Software Engineering, it is expected that 4 to 6 Teaching Assistantships will be available to support graduate students enrolled in the Software Engineering program. Additional research assistantships will be available through externally funded research projects, as mentioned above.

**Table 5: CSE Faculty funded projects over the past six years**

PI/Co-PI	Title	Agency/ Compan y	Funds	Period
Bienvenido Vélez	Effective teaching of Computer Science (CS) in rural economically challenged communities in Puerto Rico	PR Science Trust	\$70,000	9/1/19-8/31/20
Bienvenido Vélez	Google4HS: Creating a Networked Community for Improvement of Computer Science Teaching in Puerto Rico High Schools	Google	\$25,000	1/5/18-4/30/19
Heidy Sierra (PI)	CAREER: Computational Optics and Photonics for Deep Imaging of Live Tissue	NSF	\$498,905	5/1/18-4/30/23
Emmanuel Arzuaga (PI)	DCP: Improving Virtualized Data Center Resource Efficiency Using Dynamic Container Placement Strategies,	DoD	\$320,634	5/8/19-5/7/22
Emmanuel Arzuaga (Co-PI)	MRI: Development of a Real-world Microgrid Simulation/Testing Instrument	NSF	\$355,640	9/19/18-9/18/20
Emmanuel Arzuaga (PI)	RAPID: Resilience Assessment for Communications right after Emergencies/Disasters (RACE)	NSF	\$128,936	2/1/18-1/31/19
Kejie Lu (PI)	CI-New: Collaborative Research: Developing an Open Networked Airborne Computing Platform	NSF	\$242,451	9/1/17-8/31/20
Manuel Rodriguez (PI)	R15 THS: Using Twitter and Big Data Analytics to Track and Predict Health Conditions	NIH	\$359,367	9/15/15-5/1/20
Manuel Rodriguez (PI)	CRISP Type 2: Interdependent Electric and Cloud Services for Sustainable, Reliable, and Open Smart Grids	NSF	\$1,499,998	9/15/15-8/31/19
Manuel Rodriguez (PI)	CC*IIE Networking Infrastructure: SciNet: A ScienceDMZ for Science and Engineering Research at University of Puerto Rico Mayaguez	NSF	\$499,995	9/1/14-8/31/16

**Total Funds: \$2,693,084**

## 5 Physical Facilities and Equipment for Research and Education

### 5.1 Office Space

The CSE Department headquarters occupies 1,500 square feet for various administrative and support functions. This space is located in room S-220 in the Luis Stefani Building. Additionally, approximately 1,200 square feet are dedicated to 10 faculty offices. Most faculty offices are located in the Luis Stefani Building and a small number in the Faculty Offices Building.

Faculty offices vary in size, but the smallest has 120 square feet. All offices have telephones, internet connections, a computer or laptop, at least one desk, and a couple of chairs for the professors and the students during office hours. Some faculty offices also include a whiteboard, an individual printer, and extra tables depending on the available space. The faculty has a lounge and a meeting area in both buildings holding the faculty offices.

## 5.2 Classrooms

Classroom space is shared with the Electrical and Computer Engineering Department. Most lecture courses are offered in rooms S-203 to 207, and S-227 to S-229. Classrooms in the first group occupy an area of 473 square feet each and can accommodate up to 23 students while those in the second group occupy an area of 888 square feet each and can serve up to 45 students in the first two classrooms, and 38 in the third. S-227 is a classroom fully equipped for teleconference. The consolidated classroom area is 5,029 square feet in 8 classrooms. All classrooms have whiteboards, overhead projectors, and ceiling-mounted data display projectors. The department also owns four spare data display projectors that can be used by professors for their lectures, conferences, or educational activities outside the campus. All classrooms are air-conditioned.

For large groups, the Luis Stefani building auditorium with capacity of 150 students (S-113) is used when needed. It includes an amplified audio system and a ceiling-mounted data display projector. This room is mainly used for departmental tests in the evenings, and in occasions to accommodate mega-section courses, i.e. course sections with more than 45 students. This auditorium is also used for some of the shared workshops and student presentations for the capstone courses in Computer Engineering and Electrical Engineering programs. In all these areas wireless Internet connection is available for all the students. For courses with intermediate size (between 50 and 80 students), we can use the second auditorium located in room S-230. It includes a ceiling-mounted data display projector, and two white boards. This room is mainly used for industrial information sessions, and to teach large sections.

## 5.3 Instructional Computer Labs

The CSE Department has access to the Amadeus Laboratory (shared with the ECE Department), which is used for teaching courses and laboratory sessions for the courses CIIC 3011, CIIC 4010, CIIC 4020, and CIIC 4050. This laboratory is also available to support laboratory work for any other course that requires it. It consists of:

- 30 Dell OptiPlex 7070 minitowers with Intel Core i7 CPU, 32 GB of RAM, 512 GB SD, 1 Gbps Ethernet Card, and Dell 24 in monitor.
- 1 Short Range projector

Two additional computer labs with similar capacities to those the Amadeus Laboratory -INCADEL and CRAI - are used by our students and faculty for laboratory sessions as the need arises. These are also shared with the ECE department.

All these lab facilities are open 24 hours. When not in use on a laboratory session, students from our department, as well as those from the ECE department, have access to those facilities to work in course related activities. Students have access through personal electronic keys that they can acquire once they become students in one of the two departments. These lab facilities are also protected by security cameras.

In the Fall of 2021, we finished the process of adding an additional computer laboratory with similar capacities as the Amadeus Lab. This facility is located at room S-114A and has been substantially supported by a recent donation from Chevron Corporation, and with other institutional funds.

## 5.4 Distance Learning Platform

UPRM relies on the UPR **online.upr.edu** platform for the delivery of distance learning courses, and to complement face-to-face courses. This platform is based on Moodle, an open-source, on-line learning platform. According to the Moodle web site<sup>2</sup> it is a “*learning platform designed to provide educators, administrators and learners with a **single robust, secure and integrated system** to create personalised learning environments.*” The online.upr.edu platform is managed by the UPR Central Administration. Currently, most courses in the CSE Department rely on online.upr.edu to provide access to students for lectures slides, lecture videos, homework, quizzes, exams, and other educational activities. This includes face-to-face courses, hybrid courses, and distance courses for the undergraduate Software Engineering Program, undergraduate Computer Science and Engineering Program, and the Doctoral Program in Computer and Information Science and Engineering (CISE). The Faculty of the CSE Department have been trained as on-line educators, mostly through the CREAD Division at UPRM. The CSE Department has several courses that are offered in the hybrid (H) or distance (D) modality. Moreover, most programming courses (even those face-to-face) rely on online.upr.edu for:

1. Delivery of laboratory session where programming exercises are performed.
2. Delivery of homework where programming exercises are performed.
3. Delivery of mid-term exams where programming exercises are performed.

Moodle plug-ins such as JavaUnitTest and CodeRunner are used to help grading the all these programming exercises.

More complicated term-projects or multi-stage programming projects are submitted, revised and graded using online source control tools, specifically GitHub Classroom<sup>3</sup> and GitLab<sup>4</sup>. Both of these platforms are free to use for educational purposes.

Synchronous lectures and virtual office hours for these courses are managed with one of the following collaboration tools:

1. Microsoft Teams
2. Google Meet
3. Zoom

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<sup>2</sup> [https://docs.moodle.org/311/en/About\\_Moodle](https://docs.moodle.org/311/en/About_Moodle)

<sup>3</sup> GitHub Classroom - <https://classroom.github.com>

<sup>4</sup> GitLab - <https://gitlab.com/>



The online.upr.edu has several tools to manage submission of works and to verify for student academic dishonesty. These include Turnitin and Respondus.

These aforementioned technologies are sufficient for the faculty of the SWE Graduate Program to deliver course in face-to-face, hybrid, and distance modalities. Hence, the SWE Graduate Program can be delivered to student in two modalities:

1. **On-campus:** Students take their courses offered in the traditional face-to-face style in a classroom.
2. **On-line:** Students take their courses offered in the hybrid mode (H) or distance mode (D), as defined by certification 19-85 of the UPRM Academic Senate.

## 5.5 Other Campus-wide Educational Resources

The UPRM has several computing resources available for students and faculty, including a new 10gb connection to the main UPR-AC and to Internet2, a Wireless Network for the use of the students named RUMNET, this can be divided in various Wireless Networks around the Campus, (i.e. RUMNETCE, RUMNETFISH, RUMNETBIB, etc.). Students can use the WIFI access with a password. It is expected to implement in the near future, access to the WIFI networks using the campus email id. Also, the Science Network (Scinet 10gb network) is available for graduate and undergraduate researchers for high performance data. Finally, the Virtual Computing Lab (VCL) is a cloud technology service for students and professors. In VCL, users login with their UPR credentials to access available computational resources. More information about VCL can be provided upon request by the program evaluators.

Other UPRM campus tools and software available for students include, Moodle, Microsoft Office 365, Arc GIS and Minitab:

1. Moodle is an open source and free Learning Management System provides faculty an online environment to upload class material for their courses. Faculty can upload course syllabus, presentations, exams, assignments or any link o material to complement the course goals. Moodle is also use for online or hybrid courses.
2. Microsoft Office 365 is a subscription service that includes access to MS Office applications and online productivity services. UPR students have access to download and install to Office 365 software suite in their personal computers, and the use the available online services.
3. ArcGIS, Esri ArgGIS Unlimited Educational Site License, allows UPRM students and faculty to use the geographic information system ArcGIS or ArcMAP in their research. The service can be used in laboratory and faculty offices with a license server validation, and for student personal computers using an EVA key. ESRI also provides online services.
4. Minitab unlimited license allows UPRM Campus community to use, for academic purposes, the tools included in this software at the Mayagüez campus computers using a license server validation, as well as through students and faculty personal computers.

5. Microsoft Imagine Premium subscription provides students with software design and development tools free of charge. Using UPR credentials students and professors can access, the Microsoft Azure Dev Tools for Teaching.

## 5.6 Research Facilities

The following facilities are available to support the research efforts associated with the program:

***Advanced Data Management Laboratory (CID Building)*** – The Advanced Data Management Lab (ADMLab) is a laboratory that we have organized to provide support for all data management projects. The ADMLab has approximately 800 sq.ft. of space to host student desks, demonstration areas, machine room, and a meeting area.

***Parallel and Distributed Computing Laboratory (CID Building)*** – The Parallel and Distributed Computing Laboratory (PDCLab) is a laboratory that we have organized to provide support for all parallel, distributed, and grid computing projects. The PDCLab has approximately 500 sq.ft. of space to host student desks, teleconference area, and a meeting area.

***Laboratory for Applied Remote Sensing and Imaging and Photonics (LARSIP) (CID Building)***- is a multidisciplinary laboratory dedicated to the research and implementation of Remote Sensing, Hyperspectral Image Processing, Signal and Image Processing, Geographical Information Systems (GIS), Emergency Response Systems, Global Positioning Systems (GPS) technologies, Applied Electromagnetics and Bio-Optics.

***Computational Optics and Photonics Laboratory (COPLa) (CID Building)*** – This research laboratory focuses on interdisciplinary research that integrates fundamental knowledge in optical, signal processing, and computer science with targeted application to biomedical imaging and remote sensing. Research activities include to work with optical microscopes, spectral and commercial imaging instrumentation, compressed sensing and machine learning algorithms. The laboratory provides a testbed to train the workforce in imaging systems design and algorithm development for data acquisition, analysis and visualization.

## 5.7 Currently Available Research Equipment

***UPRM SciNet (Campus Wide):*** The UPRM 10Gbps Science DMZ, known as UPRM SciNet, became operational in the summer of 2015 and interconnect five (5) buildings across campus, to expose our Cyberinfrastructure capabilities to the outside world via Internet 2. These buildings are home to our research groups in Gene Sequencing, High Energy Physics, Computational Chemistry, Oceanography, Fluid Mechanics, Networking, and Big Data Analytics. SciNet will enable these groups to share their data sets, equipment, and clusters, thus enhancing our ability to insert ourselves into national research initiatives. The Science DMZ (<http://fasterdata.es.net/science-dmz/>) is a firewall-less network that can sustain high-speed data transfers (e.g., 10 Gbps) between nodes within the DMZ. It provides a highly scalable medium for the secure exchange of scientific data, and the interconnection of cluster and/or cloud

computing platforms. All security gets enforced at the communication end-points (e.g., data servers) of the network. Our faculty acquired this equipment through a competitive grant from the National Science Foundation (NSF) – Award #: ACI-1440552.

***UPRM Voyager Cluster (L. Stefani Bldg):*** This new computational facility enables our research teams to conduct state-of-the-art work in Artificial Intelligence (AI), Big Data Analytics, Computational Chemistry, Bioinformatics, Statistical Analysis, Computational Physics, and other related fields.

The cluster is organized along three service types:

- **Compute Nodes** – 32 compute nodes, each having: 2 CPUs and 24 cores, 192GB of RAM, 2 TB of local store, 2x10Gbps NiC, and InfiniBand interconnection.
- **GPU Nodes** - 12 GPU nodes with 2 CPUs and 24 cores, 192 GB of RAM, 2 x NVIDIA Tesla V100 GPU – 32 GB RAM, 4 TB of storage, and 2x10Gbps NiC.
- **Big Data Nodes** - 10 high-memory nodes 2 CPUs and 24 cores, 384GB of RAM, 2 TB of local store, and 2x10Gbps NiC.

The cluster runs Ubuntu Linux and is managed with the OpenStack platform.

***UPRM Private Cloud, known as Virtual Computing Laboratory (CTI Bldg):*** This cloud is built atop : 1) an IBM Blade Center HX5, with 40 computing cores, each capable of two parallel execution threads, and 512 Gigabytes of RAM memory, 2) 15 IBM Blade Center HS23 with 16 computing cores and 120 GB of ram, and 3) one IBM StorWise 7000 with 10 TB of storage capacity.

***UPRM Lockheed Martin private cloud facility (L. Stefani Bldg.)*** : This cloud runs Ubuntu Linux 12.04 LTS and Open Stack private cloud software. It has the following hardware:

- 12 (twelve) Dell Power Edge R420 with Intel Xeon Quad Core CPU, 8 GB RAM, 1TB disk, and 1Gbps NiC.

***EECS Experimental Cloud (CID Bldg.):*** The experimental cloud facility consists of ten (10) machines forming a cloud with the ability to build 40 VMs. The machines run Ubuntu 12.04 LTS and both Eucalyptus and OpenStack private cloud software. Each machine was custom assembled featuring:

- AMD Phenom II Quad Core CPU, 8 GB RAM, 1Gbps NiC, and 2x500 GB disk.

## **5.8 Plans for expansion and improvement**

The CSE Department is constantly monitoring its laboratory infrastructure to guarantee the proper maintenance, and the needs for upgrade or enhancement to support the SWE Graduate Program. A full-time staff of three computer and communications technicians are in charge of all the computing labs that are used by our students, the computer network infrastructure, and the centralized facilities that hosts computer servers and storage. They are responsible to constantly monitor the computer and network equipment, as well as the software systems. They are the first line of support whenever some malfunction is identified by users of these systems. Among their main duties and responsibilities, we can list the following:

- Give support to students and faculty in solving problems with the equipment in lab facilities or with the use/configuration of specialized software.
- They keep our systems up to date in the different software components that are installed.
- Contact vendors or service providers should the need arise to repair equipment that is still under some warranty.
- Inform the department of any need that requires actions from the department to make available funds to work on it; which may include to purchase new additional equipment or to replace existing one, to acquire new software, to renew software licenses or maintenance contracts, etc.
- Work with the department on strategies to enhance and upgrade our computer labs.
- Contact different vendors for quotations when new purchases are in progress.

When the need arises for a purchase, the department works on the identification of funds to support that. Different sources of funds are available for us to cover the cost that such purchases may imply. These are described under the section for Criterion 8 – Institutional Support.

Faculty members also contribute with money from their grants to support some laboratory miscellaneous supplies. Whenever the budget is not enough for supporting the enhancement or maintenance petitions, the budget to cover the need is added to the following cycle. Every three to five years the university administration assigns money in the budget to replace computers, and other obsolete equipment. Petitions for equipment for new research laboratories are submitted separately and are usually initiated by a donation or NSF Major Research Instrumentation (MRI) proposal. Donations from external sources are also used to improve our lab facilities and capacities. This is the case of the new academic computer lab that is in the process of being established in room Luis Stefani S-114A, which was furnished thanks to a donation from the Chevron Corporation.