



University of Puerto Rico  
Mayagüez Campus  
College of Agricultural Sciences  
Department of Agricultural and Biosystems Engineering



**OFFICIAL SYLLABUS**

**ANAEROBIC DIGESTION OF AGRICULTURAL WASTE  
SAGA 5016**

<b>Credit Hours:</b> 3	<b>Contact Hours:</b> Two (2) hours conference and a laboratory period of three (3) hours per week
<b>Prerequisites:</b> QUIM 3131 and QUIM 3133 or Authorization of the Director of the Department	<b>Co-requisites:</b> None
<b>Course Description (English):</b>  Study of the use of anaerobic digesters for agricultural waste management. Production of methane gas and its conversion to electrical and mechanical energy.	
<b>Course Description (Spanish):</b>  Estudio del uso de digestores anaeróbicos para el manejo de desperdicios agrícolas. Producción de gas metano y su conversión a energía eléctrica y mecánica.	
<b>Learning Objectives:</b> Upon successful completion of this course, students should be able to: <ol style="list-style-type: none"><li>Get familiar with the concept of digestion of agricultural waste in general and anaerobic digestion in particular to quantify the amount of agricultural waste that could be converted to bio-gas fuel.</li><li>Study with different anaerobic digester designs and relevant factors.</li><li>Study of conversion ratios of different agricultural wastes particularly chicken and cow manure, to bio-gas under tropical conditions.</li><li>Determine the best retention time for manure (chicken or cow) under the known climatic factors for the island.</li><li>Understand how the main limiting factors such as pH, and temperature affect the bio-gas production and solid-to-gas conversion.</li><li>Make recommendations based on experience for better handling and managements of wastes and its conversion to energy.</li></ol>	

**Content Outline and Time Distribution:**

<i>Topics to be covered</i>		<i>Contact hours</i>
I.	Introduction	1
II.	Fuel from Biomass 1. Liquid fuels 2. Gaseous 3. Heat value of fuels	3
III.	Agricultural waste - Solid, semisolid and liquid 1. Crop residue generation and availability 2. Collection and transportation of crop residues 3. Manure generation and availability 4. Collection and transportation of manures	4
IV.	Anaerobic digestion process 1. One-phase process a. The ancient one-phase slurry reactor b. The CFSTR c. The (quasi) plug-flow process 2. Two-phase process a. The two-phase slurry process b. The two-phase percolation process	6
V.	Anaerobic contact process	2
VI.	Anaerobic digester design and control	2
VII.	Anaerobic process control parameters	2
VIII.	Gas production process	2
IX.	Utilization of produced bio-gas for internal combustion engines	2
X.	Thermophilic anaerobic digestion of coffee wastewater	2
XI.	Case study of the Bacardi corporation digestion process for stabilizing RUM distillery wastes and producing methane	1
XII.	Case study of anaerobic thermophilic digestion of solid waste from the instant coffee industries	1
XIII.	Exams	2
XIV.		
XV.		
XVI.		
XVII.		
XVIII.		
<i>Total hours: (equivalent to course contact period)</i>		45

<i>Laboratories</i>		<i>Contact hours</i>
1.	To learn how the prototype model digester works and how it has been designed.	
2.	To prepare the model digester to be used for the agricultural waste under study.	
3.	How much of this waste under study is produced around the island and how farmers are disposing it or if they have any use for it.	
4.	EPA and EQB regulations and other restriction on proper disposing of agricultural waste under study.	
5.	Concepts on design of anaerobic digestion and factors.	
6.	Loading the digester with the waste under study and monitoring the parameters such as PH, Temperature, amount of bio-gas production, and ratio of solid -to-gas conversion. (The monitoring process will start after a certain period of time depending on the type of the waste and the limiting factors within the reactor). To monitor the parameters mentioned above, samples from the liquid in the digester will be taken out daily to measure the PH, and the temperature. After the production of the bio-gas, samples of gas and the quantity produced daily will also be measured.	
7.	Determination of Retention Time for the waste under experiment. Collected data and its tabulation to prepare the relevant graphics for final report.	
8.	Conclusion and recommendation for the farmers in terms of the best ways for handling and managing the particular waste and its conversion to bio-gas.	
9.		
10.		
11.		
12.		
13.		
14.		
15.		
<i>Total hours: (equivalent to laboratory contact period)</i>		45

**Instructional Techniques:**

- conference     discussion     computation     laboratory  
 seminar with formal presentation     seminar without formal presentation     workshop  
 art workshop     practice     trip     thesis     special problems  
 tutoring     research     others, please specify:

**Learning Resources and Minimum Facilities Available or Required:**

The course will be taught in a traditional classroom. Equipment such as transparencies and head projector will be used in lectures. The computer room will be used in some of the laboratories. General Library and University Computer Center is available to obtain professor's reference materials.

**Evaluation Techniques and Relative Weight:**

	<b>Percent</b>
<input checked="" type="checkbox"/> 2Exams (20% each)	40
<input type="checkbox"/> Final exam	
<input type="checkbox"/> Short quizzes	
<input checked="" type="checkbox"/> Laboratory	15
<input checked="" type="checkbox"/> Oral reports	20
<input checked="" type="checkbox"/> 5 Written Reports (3% each)	15
<input type="checkbox"/> Portfolio	
<input type="checkbox"/> Journals	
<input checked="" type="checkbox"/> Projects	10
<input type="checkbox"/> Others, specify:	
<b>TOTAL: 100%</b>	<b>100%</b>

**Grading System:**

- Quantifiable (letters)     Not Quantifiable

Standard Curve: 90 tp 100 A; 80 < 90 B; 70 < 80 C; 60 < 70 D; 0 < 60 F

**Bibliography:**

Class Notes

**According to Law 51:**

Law 51: The Comprehensive Educational Services Act for People with disabilities states that after identifying with the instructor and the institution, the student with disabilities will receive reasonable accommodation in their courses and evaluations. For more information contact the Department of Counseling and Psychological services at the Office of the Dean of Students (Office DE 21) or call 787-265-3864 or 787-832-4040 x 3772, 2040 and 3864.

**Academic Integrity:**

The University of Puerto Rico promotes the highest standards of academic and scientific integrity. Article 6.2 of the UPR Students General Bylaws (Board of Trustees Certification 13, 2009-2010) states that academic dishonesty includes, but is not limited to: fraudulent actions; obtaining grades or academic degrees by false or fraudulent simulations; copying the whole or part of the academic work of another person; plagiarizing totally or partially the work of another person; copying all or part of another person answers to the questions of an oral or written exam by taking or getting someone else to take the exam on his/her behalf; as well as enabling and facilitating another person to perform the aforementioned behavior. Any of these behaviors will be subject to disciplinary action in accordance with the disciplinary procedure laid down in the UPR Students General Bylaws.—

**Policy Against Discrimination Based on Sex, Sexual Orientation, and Gender Identity:**

The University of Puerto Rico prohibits discrimination based on sex, sexual orientation, and gender identity in any of its forms, including that of sexual harassment. According to the Institutional Policy Against Sexual Harassment at the University of Puerto Rico, Certification Num. 130, 2014-2015 from the Board of Governors, any student subjected to acts constituting sexual harassment, may turn to the Office of the Student Ombudsperson, the Office of the Dean of Students, and/or the Coordinator of the Office of Compliance with Title IX for an orientation and/or formal complaint.

**Sexual Harassment: Certification 130-2014-2015 states:**

Sexual harassment in the workplace and in the study environment is an illegal and discriminatory act and is against the best interests of the University of Puerto Rico. All persons who understand they have been subject to acts of sexual harassment at the University of Puerto Rico may file a complaint and request that the institution investigate, where necessary, and assume the corresponding action by the university authorities. If the complainant is a student, he or she must refer his or her complaint to the Office of the Student Ombudsperson or that of the Dean of Students.

**Certification 06-43 of the Academic Senate states, "The academic guidelines for offering online courses," defines:**

Traditional face-to-face courses are those that have less than 25% of the course's regular contact hours via the Internet. Therefore, a three-credit course will be considered "face to face" if, of the 45 hours of regular contact, 11 or less are taught via the Internet. According to certification 16-43 of the Academic Senate, a course may include up to 25% of its total contact hours via the Internet. The objective of this is so that all professors have this alternative in the case of any unscheduled eventuality.