



University of Puerto Rico  
Mayagüez Campus  
College of Engineering  
Department of Mechanical Engineering  
M.S./Ph.D. in Mechanical Engineering



## Course Syllabus

<b>1. General Information:</b>
Alpha-numeric codification: INME 6748 Course Title: Energy and Variational Principles in Applied Mechanics Number of credits: 3 Contact Period: Three hours of lecture per week
<b>2. Course Description:</b>
English: Application of energy and variational principles in applied mechanics using fundamental theorems from variational calculus and solid mechanics. Derivation of equations of mechanics from energy and variational principles. Formulation and solution of initial-, boundary-, and eigen-value problems using direct variational methods.
Spanish: Aplicación de principios energéticos y variacionales en la mecánica aplicada usando teoremas fundamentales del cálculo variacional y mecánica de sólidos. Derivación de las ecuaciones mecánicas usando los principios de energía y variacionales. Formulación y solución del problema de condiciones iniciales, contorno y autovalores usando métodos variacionales directos.
<b>3. Pre/Co-requisites and other requirements:</b>
Pre-requisite: Authorization of the Director of the Department
<b>4. Course Objectives:</b>
<ul style="list-style-type: none"><li>• Applying basic concepts in variational calculus.</li><li>• Expressing the relationships between stresses, strains, displacements, material properties, and external effects in the form of energy or work done by internal and external forces;</li><li>• Formulating the governing equations using variational principles for static bodies such as: bars, beams, and plates.</li><li>• Solving problems in applied mechanics using the principle of minimum total potential energy, principle of minimum total complementary potential energy, principle of virtual work, and principle of complementary virtual work.</li><li>• Formulating and solve initial-, boundary-, and eigen- value problems using direct methods such as Rayleigh Ritz, Galerkin, and Kantorovich methods.</li><li>• Applying Hamilton's principle and Lagrange equations to obtain equations of motions.</li><li>• Applying all principles to conservative and non-conservative problems.</li></ul>
<b>5. Instructional Strategies:</b>
<input checked="" type="checkbox"/> conference <input type="checkbox"/> discussion <input type="checkbox"/> computation <input type="checkbox"/> laboratory
<input type="checkbox"/> seminar with formal presentation <input type="checkbox"/> seminar without formal presentation <input type="checkbox"/> workshop
<input type="checkbox"/> art workshop <input type="checkbox"/> practice <input type="checkbox"/> trip <input type="checkbox"/> thesis <input type="checkbox"/> special problems <input type="checkbox"/> tutoring
<input type="checkbox"/> research <input type="checkbox"/> other, please specify:

<b>6. Minimum or Required Resources Available:</b>		
General Library		
<b>7. Course time frame and thematic outline</b>		
<b>General Topics</b>	<b>Contact Hours</b>	
I. Review of Apply Elasticity	4	
II. Variational Calculus	7	
III. Principle of Virtual Work (PVW)	12	
IV. Principle of Complementary Virtual Work (PCVW)	13	
V. Hamilton's Principle	4	
VI. Other classical solutions	2	
Exams	3	
<b>Total hours: (equivalent to contact period)</b>	<b>45</b>	
<b>8. Grading System</b>		
<input checked="" type="checkbox"/> Quantifiable (S/NS) <input type="checkbox"/> Not Quantifiable		
<b>9. Evaluation Strategies</b>		
	<b>Quantity</b>	<b>Percent</b>
<input checked="" type="checkbox"/> Exams	<b>3</b>	<b>75</b>
<input checked="" type="checkbox"/> Final Exam	<b>1</b>	<b>25</b>
<input type="checkbox"/> Short Quizzes		
<input type="checkbox"/> Oral Reports		
<input type="checkbox"/> Monographies		
<input type="checkbox"/> Portfolio		
<input type="checkbox"/> Projects		
<input type="checkbox"/> Journals		
<input type="checkbox"/> Other, specify:		
<b>TOTAL:</b>		<b>100%</b>
<b>10. Bibliography:</b>		
<b>Textbook:</b>		
Friedman, Avner. 2010. <i>Variational Principles and Free-Boundary Problems</i> . New York: Dover Publications. [Available at the Circulation Collection (QA379. F74 2010), UPRM General Library]		
<b>Other resources:</b>		
1. Wunderlich, W., and Walter D. Pilkey. 2002. <i>Mechanics of Structures: Variational and Computational Methods</i> . Florida: CRC Press. <a href="http://dx.doi.org/10.1201/9781420041835">http://dx.doi.org/10.1201/9781420041835</a> . [Available via MechanicalENGINEERINGnetBASE, UPRM General Library Databases] (**)		
2. Reddy, J.N. 1984. <i>Energy and variational methods in applied mechanics: With an Introduction to the Finite Element Method</i> . New Jersey: Wiley. [Available at the Circulation Collection (TA350 .R39 1984), UPRM General Library]		
3. Electronic resources available through the Library's website: <a href="http://www.uprm.edu/library/cre/listdbsp.php?l=1&amp;st=0&amp;topic=77">http://www.uprm.edu/library/cre/listdbsp.php?l=1&amp;st=0&amp;topic=77</a> .		
<b>11. Law 51: The Comprehensive Educational Services Act for People with Disabilities:</b>		
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.

## **12. 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. —

## **13. Certification 06-43 of the Academic Senate**

"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 06-43 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.

## **14. 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.

*Revised: February, 2019*