Subject name: Life cycle assessment
Course key: 76989
Type of course: Optative
Approved credits:
Last curriculum revision date: September 2020
Pre-requisite: None

A) COURSE NAME: LIFE CYCLE ASSESSMENT

Synthetic Program								
Life cycle assessment								
General Information								
Type of curriculum proposal:	New	x	Restructuring				Adjustment	
Type of subject:	Mandatory		Optative	x	Complementary		Other	
Subject shared with another EP or academic entity	(x) No ( ) Yes ¿ With which EP is shared? _____ ¿On which semester? _____ ¿From which academic entity? _____							
Elaborated by:	Madigan Martínez Parga Méndez							
Reviewed by:	Mariana Garcia de la Torre							

Semester	**Theory hours per week**	**Hours of practice per week**	**Hours of additional work student per week**	**Credits**
	3	1	1	6

Overall objective	Provide students with the tools and knowledge that allow them to perform the life cycle analysis of products or process, to contribute to the solution of environmental problems, based on the development of case studies.
Specific objective	● Provide the student with the basic concepts of life cycle analysis to identify the different stages ● Identify and explain the concepts of sustainability in the design process. ● Develop the scope and objective of a case study through the life cycle analysis. ● Detect study cases that include the integration of design into the habitat of man. ● Develop the inventory analysis of a case study of life cycle analysis. ● Develop the environmental impact assessment of a case study through the life cycle analysis ● Develop the interpretation of the results of a case study of life cycle analysis.
Specific professional competence (s) that the subject develops	● Problematize: Critically analyze the problems of the psychophysical relationship between man and the object in different contexts of use. ● Specify: Specify the characteristics of the object and design processes in the physical, perceptual, symbolic and environmental ● Manage: Innovate both in the incremental and in the radical, the objects and processes of industrial design.
Performance tasks of the specific professional competence to those which contribute to develop the subject	● Find practical solutions to develop projects by implementing the life cycle analysis in them in order to reduce urban ecological and environmental problems. ● Apply concepts and principles to ecological, urban and construction studies for the evaluation of the life cycle ● Develop the knowledge and skills that allow them to make life cycle analysis proposals in structures and products with the use of bio-environmental, green, sustainable criteria, oriented to the efficient management of resources such as water, energy or materials and resources, among others.
Transversal professional competence (s) that contribute to the development of the subject	● Complex thinking that allow learning to learn and adapt to the changing context requirements ● Social responsibility and sustainability: Actively contribute to the identification and solution of social, economic, political and environmental sustainability issues ● Criteria, norms and principles necessary to face the dilemmas of their insertion in the social and productive world

Specific objectives	Units	Content
	1. Introduction to life cycle and sustainability analysis	Introduction to life cycle analysis Environmental evaluation of processes and products Life cycle analysis
	2. Application of life cycle analysis	Tools for life cycle analysis application Computer tool presentation Application example of the computer tool
	3. Examples of environmental infrastructure evaluation	Pavements in areas of low traffic intensity (industrial and urban)
	4. Sustainability Assessment. Multicriteria decisions	Parameters for sustainability evaluation Examples of parameters in infrastructure
	5. Value analysis and Multi-attribute Utility Theory	Background, elements and types of decision Variable selection and ranking Weighting methods Assessment, aggregation and decision methods
	6. Sustainability Evaluation Models	General approach of open models Weighting, valuation and aggregation Analysis of results Probabilistic approach
	7. Open tools for the evaluation of Sustainability	Introduction to the tool Use procedure Information and results
	8. Examples of infrastructure sustainability assessment	Sanitation pipes Concrete structures (Anejo 13 of EHE-O8) Other examples

Method and practice	**Method**	The teacher's exposure with audiovisual methods, in classrooms equipped with computer hardware and software. The teacher will provide the bibliography and topics from the beginning of the course.	
	Practices		
Evaluation method	**Midterm exam**	20%	Partial exam of Unit 1 and 2
		20%	Partial exam of Unit 3 to 5
		20%	Partial exam of Unit 6 to 8
		40%	Final presentation of case analysis
	Final exam	The final exam will consist of the elaboration of an investigation where the efficiency of a building will be evaluated according to the topics seen during the course. Such evaluation will have a weighting of 40% of the final grade of the subject.	
	Other activities		

References and digital resources	**References**	Balkema, A. J., Preisig, H. A., Otterpohl, R., & Lambert, F. J. . (2002). Indicators for the sustainability assessment of wastewater treatment systems. Urban Water, 4(2), 153–161. doi:10.1016/s1462-0758(02)00014-6 Campos-Guzmán, V., García-Cáscales, M. S., Espinosa, N., & Urbina, A. (2019). Life Cycle Analysis with Multi-Criteria Decision Making: A review of approaches for the sustainability evaluation of renewable energy technologies. Renewable and Sustainable Energy Reviews, 104, 343–366. doi:10.1016/j.rser.2019.01.031 Carlos Romero. Análisis de las Decisiones Multicriterio. Primera edición. Madrid: Isdefe - Ingeniería de Sistemas, 1996. ISBN 84-89338-14-0. DONG, C., ZHANG, C., & WANG, B. (2003). Integration of Green Quality Function Deployment and Fuzzy Multi-Attribute Utility Theory - Based Cost Estimation for Environmentally Conscious Product Development. International Journal of Environmentally Conscious Design & Manufacturing, 11(1), 12–28. European Commission - Joint Research Centre - Institute for Environment and Sustainability. International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition. Luxembourg.: Publications Office of the European Union, 2010. ISBN 978-92-79-19092-6. Geneletti, D., & Ferretti, V. (n.d.). Multicriteria analysis for sustainability assessment: concepts and case studies. Handbook of Sustainability Assessment, 235–264. doi:10.4337/9781783471379.00019 Gervásio, H., & Simões da Silva, L. (2012). A probabilistic decision-making approach for the sustainable assessment of infrastructures. Expert Systems with Applications, 39(8), 7121–7131. doi:10.1016/j.eswa.2012.01.032 Gjorv, O. E. (2018). Concrete Technology for a Sustainable Development in the 21st Century. In Concrete Technology for a Sustainable Development in the 21st Century. https://doi.org/10.1201/9781482272215

Halog, A., & Manik, Y. (2011). Advancing Integrated Systems Modelling Framework for Life Cycle Sustainability Assessment. Sustainability, 3(2), 469–499. doi:10.3390/su3020469

Hauschild, M. Z., Goedkoop, M., Guinée, J., Heijungs, R., Huijbregts, M., Jolliet, O., … Pant, R. (2012). Identifying best existing practice for characterization modeling in life cycle impact assessment. The International Journal of Life Cycle Assessment, 18(3), 683–697. doi:10.1007/s11367-012-0489-5

Heijungs, R., Huppes, G., & Guinée, J. B. (2010). Life cycle assessment and sustainability analysis of products, materials and technologies. Toward a scientific framework for sustainability life cycle analysis. Polymer Degradation and Stability, 95(3), 422–428. doi:10.1016/j.polymdegradstab.2009.11.

ILCD (International Reference Life Cycle Data System) handbook. General guide for Life Cycle Assessment- Detailed guidance.

Inyim, P., Pereyra, J., Bienvenu, M., & Mostafavi, A. (2016). Environmental assessment of pavement infrastructure: A systematic review. Journal of Environmental Management, 176, 128–138. doi:10.1016/j.jenvman.2016.03.042

ISO 14040:2006 NMX-SAA-14044-IMCN-2008. Gestión Ambiental-Análisis de Ciclo de Vida. Principios y marco de referencia.

ISO 14044:2006 NMX-SAA-14044-IMCN-2008. Gestión Ambiental-Análisis de Ciclo de Vida. Requisitos y Directrices. Geotermia (2011). Centro de Investigación en Energía, UNAM.

Jayal, A. D., Badurdeen, F., Dillon, O. W., & Jawahir, I. S. (2010). Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels. CIRP Journal of Manufacturing Science and Technology, 2(3), 144–152. doi:10.1016/j.cirpj.2010.03.006

Kloepffer, W. (2008). Life cycle sustainability assessment of products. The International Journal of Life Cycle Assessment, 13(2), 89–95. doi:10.1065/lca2008.02.376

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Mark Goedkoop, An De Schryver, Michiel Oele, Sipke Durksz y Douwe de Roest. SimaPro 7 - Introduction into LCA. Report version 4.5. Amersfoort, Holanda: Pré Consultants, 2010.

Mark Goedkoop, An De Schryver, Michiel Oele, Douwe de Roest, Marisa Vieira y Sipke Durksz. SimaPro 7

Moretti, L., Di Mascio, P., & D'Andrea, A. (2013). Environmental Impact Assessment of Road Asphalt Pavements. Modern Applied Science, 7(11). doi:10.5539/mas.v7n11p1

Mulder, K. Desarrollo sostenible para ingenieros [en línea]. Reimpresión de la primera edición. Barcelona: Edicions UPC, 2007 [Consulta: 22/09/2016]. Disponible a: <http://hdl.handle.net/2099.3/36831>. ISBN 9788483018927.

Navarro, I. J., Yepes, V., & Martí, J. V. (2019). A Review of Multicriteria Assessment Techniques Applied to Sustainable Infrastructure Design. Advances in Civil Engineering, 2019, 1–16. doi:10.1155/2019/6134803

Ross, A. M. (2006). Managing Unarticulated Value: Changeability in Multi-Attribute Tradespace Exploration.

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Scientific Applications International Corporation (SAIC). Life cycle assessment principles and practice. Reston, VA, Estats Units, 2006.

Sergio Barba-Romero Casillas y Jean-Charles Pomerol. Multicriterion Decision in Management: Principles and Practice.

Sahely, H. R., Kennedy, C. A., & Adams, B. J. (2005). Developing sustainability criteria for urban infrastructure systems. Canadian Journal of Civil Engineering, 32(1), 72–85. doi:10.1139/l04-072

Softcover reprint of the original 1st ed. 2000. Springer, 2012. ISBN 978-1461370086.

		World Commission on Environment and Development. Our common future. Oxford: Oxford University, 1987. ISBN 019282080X. Zoccali, P., Moretti, L., Di Mascio, P., Loprencipe, G., D'Andrea, A., Bonin, G., … Caro, S. (2018). Analysis of natural stone block pavements in urban shared areas. Case Studies in Construction Materials, 8, 498–506. doi:10.1016/j.cscm.2018.04.004
	Digital resources	Proyecto sobre cultura y sustentabilidad en Iberoamérica http://www.oei.es/icsi/documentos.htm Derechos culturales y derechos de propiedad intelectual http://www.biotech.bioetica.org/docta5.htm Patrimonio cultural, valoración de bienes muebles y sustentabilidad http://espanol.geocities.com/kolodion/patri_asp_econom.pdf

B) CONTENTS AND METHODS BY UNITS AND TOPICS

Unit 1. Introduction to life cycle and sustainability analysis		**6h**
Topic 1.1 Introduction to life cycle analysis		**3h**
Subtopic	1.1.1 Introduction 1.1.2 Sustainable Development and Sustainability 1.1.2.1. Background and Historical Development 1.1.2.2. Application to the construction and infrastructure sector 1.1.3 Life cycle of processes and products 1.1.3.1. Relevance of the concept 1.1.3.2. Infrastructure application	
Tema 1.2 Evaluación ambiental de procesos y productos. Análisis del ciclo de vida		**3h**
Subtopic	1.2.1 Definition of life cycle analysis 1.2.2 Main stages 1.2.3 Flowchart and life cycle inventory 1.2.3.1. Assignment of impacts 1.2.4 Evaluation of life cycle impacts 1.2.4.1. Classification. Impact categories 1.2.4.2. Characterization 1.2.4.3. Standardization, grouping and weighting 1.2.4.4. Types of models and methodologies	

	1.2.5 Carbon and water footprints 1.2.5.1. Carbon footprint 1.2.5.2. Water footprint	
References and digital resources	**References**	**1.1 Introduction to life cycle analysis** ISO 14040:2006 NMX-SAA-14044-IMCN-2008. Gestión Ambiental-Análisis de Ciclo de Vida. Principios y marco de referencia. ISO 14044:2006 NMX-SAA-14044-IMCN-2008. Gestión Ambiental-Análisis de Ciclo de Vida. Requisitos y Directrices. Geotermia (2011). Centro de Investigación en Energía, UNAM ILCD (International Reference Life Cycle Data System) handbook. General guide for Life Cycle Assessment-Detailed guidance. Mulder, K. Desarrollo sostenible para ingenieros [en línea]. Reimpresión de la primera edición. Barcelona: Edicions UPC, 2007 [Consulta: 22/09/2016]. Disponible a: <http://hdl.handle.net/2099.3/36831>. ISBN 9788483018927.
	Digital resources	**1.2 Environmental evaluation of processes and products. Life cycle analysis** European Commission - Joint Research Centre - Institute for Environment and Sustainability. International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition. Luxembourg.: Publications Office of the European Union, 2010. ISBN 978-92-79-19092-6.
Teaching methods	Teacher's presentation with audiovisual methods, in classrooms equipped with computer hardware and software, The teacher will provide the bibliography and topics from the beginning of the course. An object of study will be determined as an application project in GIS and SIU that will be reviewed according to programmatic advances by the person in charge of the course.	

Learning activities	Integration of work teams Preparation of a report that applies GIS tools in its synthesis workshop exercise Work in virtual environments (platforms and quick demonstrations)

Unit 2. Application of life cycle analysis			**6h**
Topic 2.1 Tools for the life cycle analysis application			**2h**
Subtopic	2.1.1 Computer tools and databases 2.1.2 Databases		
Topic 2.2 Presentation of a computer tool			**2h**
Subtopic	2.2.1 Background 2.2.2 Main databases 2.2.3. Impact Methodologies 2.2.4. User interface		
Topic 2.3 Example of application of the computer tool			**2h**
Subtopic	2.3.1 Objectives and scope 2.3.2 Entering inventory data 2.3.3 Creation of assemblies and life cycles of the process or product phases 2.3.4 Presentation and interpretation of results. Analysis and comparison		
References and digital resources	**References**	**2.1 Tools for the life cycle analysis application** Softcover reprint of the original 1st ed. 2000. Springer, 2012. ISBN 978-1461370086. Mark Goedkoop, An De Schryver, Michiel Oele, Sipke Durksz y Douwe de Roest. SimaPro 7 - Introduction into LCA. Report version 4.5. Amersfoort, Holanda: Pré Consultants, 2010. Mark Goedkoop, An De Schryver, Michiel Oele, Douwe de Roest, Marisa Vieira y Sipke Durksz. SimaPro 7 Tutorial. Report version 3.5. Amersfoort, Holanda: Pré Consultants, 2010.	
	Digital resources	**2.3 Example of application of the computer tool** labein-tecnalia - UPV-EHU - UPC. La medida de la sostenibilidad en edificación industrial - Modelo Integrado de Valor de Edificios Sostenibles (MIVES). 1ª	

		Edición. Bilbao: Eduardo Rojí - coordinador, 2006. ISBN 84-690-2629-1.
Teaching methods	Teacher's presentation with audiovisual methods, in classrooms equipped with computer hardware and software. The teacher will provide the bibliography and topics from the beginning of the course. An object of study will be determined as an application project in GIS and SIU that will be reviewed according to programmatic advances by the person in charge of the course.	
Learning activities	Integration of work teams Preparation of a report that applies GIS tools in its synthesis workshop exercise Work in virtual environments (platforms and quick demonstrations)	

Unit 3. Examples of infrastructure environmental assessment		**6h**
Unit 3.1 Pavements in areas of low traffic intensity (industrial and urban)		**3h**
Subtopic	3.1. Approach and background. Applied methodology 3.1.2 Objectives, functional unit and system limits 3.1.3 Life cycle inventory 3.1.4 Impact assessment 3.1.5 Results and analysis	
Tema 3.2 Other examples of literature		**3h**
Subtopic	3.2.1 Railroad tie 3.2.2 Urban sanitation networks 3.2.3 Road pavements 3.2.4 Bridges	
References and digital resources	**References**	**3. Examples of infrastructure environmental assessment** Mulder, K. Desarrollo sostenible para ingenieros [en línea]. Reimpresión de la primera edición. Barcelona: Edicions UPC, 2007 [Consulta: 22/09/2016]. Disponible a: <http://hdl.handle.net/2099.3/36831>. ISBN 9788483018927. Scientific Applications International Corporation (SAIC). Life cycle assessment principles and practice. Reston, VA, Estats Units, 2006.

		3.1 Pavements in areas of low traffic intensity (industrial and urban **)**Moretti, L., Di Mascio, P., & D'Andrea, A. (2013). Environmental Impact Assessment of Road Asphalt Pavements. Modern Applied Science, 7(11). doi:10.5539/mas.v7n11p1 Zoccali, P., Moretti, L., Di Mascio, P., Loprencipe, G., D'Andrea, A., Bonin, G., … Caro, S. (2018). Analysis of natural stone block pavements in urban shared areas. Case Studies in Construction Materials, 8, 498–506. doi:10.1016/j.cscm.2018.04.004 **3.2 Other examples of literature** Inyim, P., Pereyra, J., Bienvenu, M., & Mostafavi, A. (2016). Environmental assessment of pavement infrastructure: A systematic review. Journal of Environmental Management, 176, 128–138. doi:10.1016/j.jenvman.2016.03.042
	Digital resources	
Teaching methods	Teacher's presentation with audiovisual methods, in classrooms equipped with computer hardware and software, The teacher will provide the bibliography and topics from the beginning of the course. An object of study will be determined as an application project in GIS and SIU that will be reviewed according to programmatic advances by the person in charge of the course.	
Learning activities	Integration of work teams Preparation of a report that applies GIS tools in its synthesis workshop exercise Work in virtual environments (platforms and quick demonstrations)	

Unit 4. Sustainability evaluation. Multicriteria decisions		**6h**
Topic 4.1 Parameters for sustainability assessment		**3h**
Subtopic	4.1.1 Parameter types 4.1.2 Deterministic and probabilistic approaches 4.1.3 Need for multicriteria decision methodologies 4.1.4 Open and closed models	
Topic 4.2 Examples of infrastructure parameters		**3h**

Subtopic	4.2.1 Environmental Pillar 4.2.2 Economic Pillar 4.2.3 Social Pillar 4.2.4. Other parameters	
References and digital resources	**References**	**4.1 Parameters for sustainability assessment**Campos-Guzmán, V., García-Cáscales, M. S., Espinosa, N., & Urbina, A. (2019). Life Cycle Analysis with Multi-Criteria Decision Making: A review of approaches for the sustainability evaluation of renewable energy technologies. Renewable and Sustainable Energy Reviews, 104, 343–366. doi:10.1016/j.rser.2019.01.031 Carlos Romero. Análisis de las Decisiones Multicriterio. Primera edición. Madrid: Isdefe - Ingeniería de Sistemas, 1996. ISBN 84-89338-14-0. Geneletti, D., & Ferretti, V. (n.d.). Multicriteria analysis for sustainability assessment: concepts and case studies. Handbook of Sustainability Assessment, 235–264. doi:10.4337/9781783471379.00019 Halog, A., & Manik, Y. (2011). Advancing Integrated Systems Modelling Framework for Life Cycle Sustainability Assessment. Sustainability, 3(2), 469–499. doi:10.3390/su3020469 Mark Goedkoop, An De Schryver, Michiel Oele, Sipke Durksz y Douwe de Roest. SimaPro 7 - Introduction into LCA. Report version 4.5. Amersfoort, Holanda: Pré Consultants, 2010. Mark Goedkoop, An De Schryver, Michiel Oele, Douwe de Roest, Marisa Vieira y Sipke Durksz. SimaPro 7 Tutorial. Report version 3.5. Amersfoort, Holanda: Pré Consultants, 2010.

		Sergio Barba-Romero Casillas y Jean-Charles Pomerol. Multicriterion Decision in Management: Principles and Practice. **4.2 Examples of parameters in infrastructure** Gervásio, H., & Simões da Silva, L. (2012). A probabilistic decision-making approach for the sustainable assessment of infrastructures. Expert Systems with Applications, 39(8), 7121–7131. doi:10.1016/j.eswa.2012.01.032 Navarro, I. J., Yepes, V., & Martí, J. V. (2019). A Review of Multicriteria Assessment Techniques Applied to Sustainable Infrastructure Design. Advances in Civil Engineering, 2019, 1–16. doi:10.1155/2019/6134803 Sahely, H. R., Kennedy, C. A., & Adams, B. J. (2005). Developing sustainability criteria for urban infrastructure systems. Canadian Journal of Civil Engineering, 32(1), 72–85. doi:10.1139/l04-072
	Digital resources	
Teaching methods	Teacher's presentation with audiovisual methods, in classrooms equipped with computer hardware and software, The teacher will provide the bibliography and topics from the beginning of the course. An object of study will be determined as an application project in GIS and SIU that will be reviewed according to programmatic advances by the person in charge of the course.	
Learning activities	Integration of work teams Preparation of a report that applies GIS tools in its synthesis workshop exercise Work in virtual environments (platforms and quick demonstrations)	

Unit 5. Value analysis and Multi-attribute Utility Theory		**6h**
Topic 5.1 Background, elements and types of decision		**2h**
Subtopic	5.1.1 Background and approach 5.1.2 Structure and terminology 5.1.3 Method classification	
Topic 5.2 Variable selection and ranking		**1h**

Subtopic	5.2.1 Characteristics of the variables 5.2.2 Estructura de las variables. Árbol de requerimientos		
Topic 5.3 Weighting methods			**1h**
Subtopic	5.3.1 Approach 5.3.2 Direct, ordinal, cardinal and comparison methods 5.3.3 Analytical hierarchical analysis		
Topic 5.4 Assessment, aggregation and decision methods			**2h**
Subtopic	5.4.1 Value functions 5.4.2 Aggregation methods 5.4.3 Multi-attribute decision techniques		
References and digital resources	**References**	**5. Value analysis and Multi-attribute Utility Theory** Dong, C., Zhang, C., & Wang, B. (2003). Integration of Green Quality Function Deployment and Fuzzy Multi-Attribute Utility Theory - Based Cost Estimation for Environmentally Conscious Product Development. International Journal of Environmentally Conscious Design & Manufacturing, 11(1), 12–28. Mark Goedkoop, An De Schryver, Michiel Oele, Sipke Durksz y Douwe de Roest. SimaPro 7 - Introduction into LCA. Report version 4.5. Amersfoort, Holanda: Pré Consultants, 2010. Mark Goedkoop, An De Schryver, Michiel Oele, Douwe de Roest, Marisa Vieira y Sipke Durksz. SimaPro 7 Tutorial. Report version 3.5. Amersfoort, Holanda: Pré Consultants, 2010. Ross, A. M. (2006). Managing Unarticulated Value: Changeability in Multi-Attribute Tradespace Exploration.
	Digital resources	
Teaching methods	Teacher's presentation with audiovisual methods, in classrooms equipped with computer hardware and software, The teacher will provide the bibliography and topics from the beginning of the course. An object of study will be determined as an application project in GIS and SIU that will be reviewed according to programmatic advances by the person in charge of the course.		

Learning activities	Integration of work teams Preparation of a report that applies GIS tools in its synthesis workshop exercise Work in virtual environments (platforms and quick demonstrations)

Unit 6. Sustainability Evaluation Models			**6h**
Topic 6.1 General approach of open models			**2h**
Subtopic	6.1.1 Requirements tree 6.1.2 Components 6.1.3 Life cycle		
Topic 6.2 Weighting, valuation and aggregation			**2h**
Subtopic	6.2.1 Direct weighting and comparison by pairs 6.2.2 Value functions 6.2.3 Aggregation procedure		
Topic 6.3 Analysis of results			**1h**
Subtopic	6.3.1 Selection criteria 6.3.2 Relative variation matrices		
Topic 6.4 Probabilistic approach			**1h**
Subtopic	6.4.1 Procedure 6.4.2 Results		
References and digital resources	**References**	**6.1 General approach of open models** Jayal, A. D., Badurdeen, F., Dillon, O. W., & Jawahir, I. S. (2010). Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels. CIRP Journal of Manufacturing Science and Technology, 2(3), 144–152. doi:10.1016/j.cirpj.2010.03.006 Hauschild, M. Z., Goedkoop, M., Guinée, J., Heijungs, R., Huijbregts, M., Jolliet, O., … Pant, R. (2012). Identifying best existing practice for characterization modeling in life cycle impact assessment. The International Journal of Life Cycle Assessment, 18(3), 683–697. doi:10.1007/s11367-012-0489-5 Heijungs, R., Huppes, G., & Guinée, J. B. (2010). Life cycle assessment and sustainability analysis of products,	

		materials and technologies. Toward a scientific framework for sustainability life cycle analysis. Polymer Degradation and Stability, 95(3), 422–428. doi:10.1016/j.polymdegradstab.2009.11.
	Digital resources	
Teaching methods	Teacher's presentation with audiovisual methods, in classrooms equipped with computer hardware and software, The teacher will provide the bibliography and topics from the beginning of the course. An object of study will be determined as an application project in GIS and SIU that will be reviewed according to programmatic advances by the person in charge of the course.	
Learning activities	Integration of work teams Preparation of a report that applies GIS tools in its synthesis workshop exercise Work in virtual environments (platforms and quick demonstrations)	

Unit 7. Open tool for the Evaluation of Sustainability		**6h**
Topic 7.1 Introduction to the tool		**1h**
Subtopic	7.1.1 Structure and access to the application	
Topic 7.2 Procedure for use		**2h**
Subtopic	7.2.1 Modules and interfaces between them 7.2.2 Programmer module 7.2.3 User module 7.2.4 Report module	
Topic 7.3 Information and results		**3h**
Subtopic	7.3.1 Information output 7.3.2 Results 7.3.3 Analysis	
References and digital resources	**References**	**7. Open tool for the Evaluation of Sustainability** Kloepffer, W. (2008). Life cycle sustainability assessment of products. The International Journal of Life Cycle Assessment, 13(2), 89–95. doi:10.1065/lca2008.02.376 Mark Goedkoop, An De Schryver, Michiel Oele, Sipke Durksz y Douwe de Roest. SimaPro 7 - Introduction into LCA. Report version 4.5. Amersfoort, Holanda: Pré Consultants, 2010.

		Mark Goedkoop, An De Schryver, Michiel Oele, Douwe de Roest, Marisa Vieira y Sipke Durksz. SimaPro 7 Tutorial. Report version 3.5. Amersfoort, Holanda: Pré Consultants, 2010. ILCD (International Reference Life Cycle Data System) handbook. General guide for Life Cycle Assessment-Detailed guidance.
	Digital resources	

Unit 8. Examples of infrastructure sustainability assessment		**6h**
Topic 8.1 Sanitation pipes		**2h**
Subtopic	8.1.1 Approach and background. Applied Methodology 8.1.2 Requirements tree 8.1.3 Weighting 8.1.4 Value functions 8.1.5 Alternatives 8.1.6 Results and analysis	
Unit 8.2 Concrete structures (Anejo 13 of EHE-O8)		**2h**
Subtopic	8.2.1 Approach and background. Applied methodology 8.2.2 Requirements tree 8.2.3 Value functions 8.2.4 Sustainability Index 8.2.5. Probabilistic approach	
Topic 8.3 Other examples		**2h**
Subtopic	8.3.1 Industrial concrete pavements 8.3.2 Rainwater harvesting infrastructures 8.3.3 Electric mobility infrastructure	
References and digital resources	**References**	**8.1 Sanitation pipes** Balkema, A. J., Preisig, H. A., Otterpohl, R., & Lambert, F. J. . (2002). Indicators for the sustainability assessment of wastewater treatment systems. Urban Water, 4(2), 153–161. doi:10.1016/s1462-0758(02)00014-6 Lundie, S., Peters, G. M., & Beavis, P. C. (2004). Life Cycle Assessment for Sustainable Metropolitan Water Systems

		Planning. Environmental Science & Technology, 38(13), 3465–3473. doi:10.1021/es034206m **8.2 Concrete structures (Anejo 13 of EHE-O8)** Gjorv, O. E. (2018). Concrete Technology for a Sustainable Development in the 21st Century. In Concrete Technology for a Sustainable Development in the 21st Century. https://doi.org/10.1201/9781482272215 Sakai, K., & Noguchi, T. (2012). The Sustainable Use of Concrete. In The Sustainable Use of Concrete. https://doi.org/10.1201/b12355
	Digital resources	
Teaching methods	Teacher's presentation with audiovisual methods, in classrooms equipped with computer hardware and software, The teacher will provide the bibliography and topics from the beginning of the course. An object of study will be determined as an application project in GIS and SIU that will be reviewed according to programmatic advances by the person in charge of the course.	
Learning activities	Integration of work teams Preparation of a report that applies GIS tools in its synthesis workshop exercise Work in virtual environments (platforms and quick demonstrations)	

C) TEACHING AND LEARNING STRATEGIES

Teacher's exposure with audiovisual methods, in classrooms equipped with computer hardware and software.
The teacher will provide the bibliography and topics from the beginning of the course.
An object of study will be determined as an application project in GIS that will be reviewed according to programmatic advances by the person in charge of the course.
Computer environment work will be coordinated by an expert technical assistant in software management. The work sessions will be in the Laboratory, with specialized and updated software and hardware.

D) EVALUATION AND ACCREDITATION

Preparation and / or presentation of:	Periodicity	Covers	Weight of each period in relation to the course
First partial exam:	At the end of Unit 2	Units 1 to 2	20%

Second partial exam:	At the end of Unit 5	Units 3 to 5	20%
Third partial exam:	At the end of Unit 8	Unit 6 to 8	20%
Final project	-	-	40%
		TOTAL	100%
Ordinary Exam	The ordinary final grade will consist of the 3 partial grades (60%) and the final project (40%).		
Other required academic activities	Non-mandatory special activities will not have a value for the evaluation of partials. This consists of attending special events on the subject or participation as organizers in events of the discipline, whether from the University or outside it as dissemination and training activities.		

E) REFERENCES AND DIGITAL RESOURCES

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Web Sites

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Derechos culturales y derechos de propiedad intelectual
http://www.biotech.bioetica.org/docta5.htm

Patrimonio cultural, valoración de bienes muebles y sustentabilidad

http://espanol.geocities.com/kolodion/patri_asp_econom.pdf