

## SYS 670: Environmental Systems Engineering Operations

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**Classes:** T/H 0930 - 1045

**Room:** MEC 347

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**Textbook:** *Introduction to Environmental Engineering*, by P. Arne Vesilind, Susan M. Morgan, Lauren G. Heine, 3rd Edition. CL Engineering, 2009. (VMH)

**Reserved:** *Elementary Principles of Chemical Processes*; by Richard M. Felder, Ronald W. Rousseau, Wiley 2004. (FR)

**Supplement:** *Water and Wastewater Technology*; 5<sup>th</sup> Edition. Mark J. Hammer, Mark J, Hammer Jr. Prentice Hall, 2004. (HH)

**Supplement:** *Integrated Solid Waste Management : Engineering Principles and Management Issues*. George Tchobanoglous, Hilary Theisen, Samuel Vigil. 2<sup>nd</sup> Edition. Mc Graw-Hill. 1993. (TTV)

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## Table of Contents

1. Course Description.....	2
2. Semester Schedule.....	3
3. Major Units Supplementary Readings.....	4
4. Textbooks: .....	5

## 1. Course Description & Grading

This course covers the unit processes of drinking water supply (DWS), wastewater and sewage treatment (WST), and municipal solid waste management (MSW) as integrated services in a system of water and sanitation (wasan) infrastructure. The course will include a review of materials and energy balances, the public policies related to water and sanitation in the US, and the global issues surrounding access to safe water and sanitation in the context of the UN's Millennium Development Goals. It is intended as an introductory or review course for graduate students in.

There will be a weekly problem set and a semester-long course project with associated oral presentation and written report.

The major units for this course are:

**Unit 1. Mass and Energy Balances (2 wks)**

**Unit 2. Unit processes for drinking water supply (3 wks)**

**Unit 3. Unit processes for wastewater and sewage treatment (3 wks)**

**Unit 4. Unit processes for municipal solid waste management (2 wks)**

**Unit 5. Policy context (2 wks)** *WASAN in the US and global contexts*

**Unit 6. Capacity factor analysis & developing communities (1 wk)** *Case studies from Limpopo South Africa (DWS, WST); and Bacoor, Cavite – the Philippines (MSW)*

**Unit 7. Project report and presentations (1 wk)**

### Grading

<b>Problem sets (best 10 of 12)</b>	<b>60%</b>
<b>Project presentation</b>	<b>15%</b>
<b>Project report</b>	<b>15%</b>
<b>In-class discussion (based on 26 sessions)</b>	<b>10%</b>
<b>TOTAL</b>	<b>100%</b>

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## 2. Semester Schedule

Week #	Class #	Date	Topic	Notes
Week 1	1	8/25/09	Fundamentals of Material Balances	FR4: <b>A1</b>
	2	8/27/09	Material Balance Calculation	FR4,VMH4
Week 2	3	9/1/09	Fundamentals of Energy Balances	FR7,VMH7: <b>A2</b>
	4	9/3/09	Energy Balance Calculation	FR7,VMH7
Week 3	5	9/8/09	Water Quality	VMH9: <b>A3</b>
	6	9/10/09	Water Quality	VMH9
Week 4	7	9/15/09	Water Supply, Treatment	VMH10: <b>A4</b>
	8	9/17/09	Water Supply, Treatment	VMH10
Week 5	9	9/22/09	Water Distribution	HH6: <b>A5</b>
	10	9/24/09	Water Distribution	HH6
Week 6	11	9/29/09	Wastewater Treatment	VMH11: <b>A6</b>
	12	10/1/09	Wastewater Treatment	VMH11: <b>A7</b>
		10/6/09	<i>Reading Day</i>	No Class
Week 7	13	10/8/09	Wastewater Treatment	HH11
	14	10/13/09	Wastewater Treatment	HH11: <b>A8</b>
Week 8	15	10/15/09	Tertiary Wastewater Treatment	VMH11, HH13
	16	10/20/09	Tertiary Wastewater Treatment	VMH11, HH13: <b>A9</b>
Week 9	17	10/22/09	Solid Waste Management	VMH14
	18	10/27/09	Solid Waste Management	VMH14,; <b>A10</b>
Week 10	19	10/29/09	Solid Waste: Treatment/Disposal	TTV5-11
	20	11/3/09	Solid Waste: Treatment/Disposal	TTV5-11: <b>A11</b>
Week 11	21	11/5/09	US WASAN Public Policy: SDWA, CWA, RCRA	TBD
	22	11/10/09	US WASAN Public Policy: SDWA, CWA, RCRA	TBD: <b>A12</b>
Week 12	23	11/12/09	International Standards for WASAN Services	TBD
	24	11/17/09	WASAN Services in Developing Communities	TBD
Week 13	25	11/19/09	Capacity Factor Approach Intro: Limpopo	TBD
	26	11/24/09	Capacity Factor Approach Intro: Bacoor	TBD: <b>Report</b>
		11/26/09	Thanksgiving Recess	No Class
Week 14	27	12/1/09	Student Presentations 1, 2, 3	<b>Presentation</b>
	28	12/3/09	Student Presentations 4, 5, 6	<b>Presentation</b>
Week 15	29	12/8/09	Student Presentations 7, 8 & Discussion	Last Class

- FR2 – Felder & Rousseau Chapter 2.
- VMH7 – Vesilind, Morgan & Heine Chapter 7
- HH2,3 – Hammer & Hammer Chapters 2 and 3.
- TTV5-11 - Tchobanoglous, Theisen, & Vigil Chapters 5 to 11.
- A1 – Assignment 1.
- WASAN – Water and Sanitation

### 3. Major Units Supplementary Readings

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**Unit 1. Mass and Energy Balances (2 wks); Weeks 1-2**

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No supplementary readings

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**Unit 2. Unit 2. Unit processes for drinking water supply (3 wks); Weeks 3-5**

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*Small community water supplies : technology, people and partnership* (TP 40-E). Smet, J. and Christine van Wijk, (2002). IRC International Water and Sanitation Centre, Delft, the Netherlands. [Available online for free](#)

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**Unit 3. Unit 3. Unit processes for wastewater and sewage treatment (3 wks); Weeks 6-8**

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*Greywater recycling: treatment options and applications*, by M. Pidou PhD, F. A. Memon PhD, DIC, CEng, CEnv, MCIWEM, T. Stephenson PhD, DIC, CEng, FIChemE, FCIWEM, B. Jefferson PhD and P. Jeffrey PhD, CSci, FCIWEM. *Proceedings of the Institution of Civil Engineer s Engineering Sustainability 160 September 2007 Issue ES3 Pages 119–131 doi: 10.1680/ensu.2007.160.3.119*

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**Unit 4. Unit processes for municipal solid waste management (2 wks); Weeks 9-10**

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*State of Garbage in America* BioCycle December 2008, Vol. 49, No. 12, p. 22,

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**Unit 5. Policy Context (2 wks): Legislation, Regulation, Week 11-12**

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**Reading:** Readings on SDWA (1972), CWA (1974), RCRA (1976), CERCLA (1980, 1986)

Readings on WHO and other standards for WASAN (in low income countries)

1. United States: Primarily Regulatory Approach
2. Netherlands: Primarily Consensual approach (evolved from a systems approach)
3. International Standards for WASAN. WHO/UNICEF, Other.

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**Unit 6. .Capacity Factor Analysis : Cases from developing communities (1 wk); Week 12-13**

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1. Effects of low institutional capacity
2. Mixed policy methods: Regulatory/Consensual/Industry generated
3. The use of the private sector for policy setting

**Readings :** Louis & Bouabid, 2004.

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**Unit 7. Project Report and Oral Presentations (1 wk); Week 14**

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Student presentations. Student reports. Discussion.

## 4. Textbooks, Readings and Other References:

### Unit 1: Mass and Energy Balances (2 wks)

*Elementary Principles of Chemical Processes*; by Richard M. Felder (Author), Ronald W. Rousseau, Wiley 2004 [Amazon](#)

### Unit 2: Unit processes for drinking water supply (2 wks)

*Introduction to Environmental Engineering*, by P. Aarne Vesilind, Susan M. Morgan, Lauren G. ; (3rd edition May 19, 2009) Heine, CL-Engineering [Amazon](#)

### Unit 3. Unit processes for wastewater and sewage treatment (2 wks)

*Small community water supplies : technology, people and partnership* (TP 40-E). Smet, J. and Wijk, Christine van (2002). IRC International Water and Sanitation Centre, Delft, the Netherlands. [Available online for free](#)

### Unit 4. Unit processes for (2 wks)

*Municipal Wastewater Management in Developing Countries: Principles and Engineering* (Hardcover) by Zaini Ujang (Editor), Mogens Henze (Editor) IWA Publishing (Intl Water Assoc) (April 30, 2006) [Amazon](#)

### Unit 5. Unit processes for municipal solid waste management (2 wks)

*Integrated Solid Waste Management: Engineering Principles and Management Issues* (Paperback), George Tchobanoglous (Author), Hilary Theisen (Author), Samuel A. Vigil (Author), McGraw-Hill Publishing 1993 [Amazon](#)

*Handbook of Solid Waste Management* (Hardcover) by Frank Kreith (Author), George Tchobanoglous (Author). McGraw-Hill Professional; 2 edition (June 22, 2002) [Amazon](#)

### Appropriate Technologies

*Field Guide of Appropriate Technology* by Barrett Hazeltine (Editor) Academic Press 2002<sup>1</sup>

*World Changing: A User's Guide for the 21st Century*, Alex Steffen (2008)<sup>2</sup>

### Reference Texts:

*Water Encyclopedia, Five-Volume Set* (Hardcover) by Jay H. Lehr (Editor), Jack Keeley (Editor) Wiley-Interscience; 1 edition (June 13, 2005)

*Environmental Engineering* by Howard S. Peavy, D.R. Rowe, and George Tchobanoglous (Paperback - Mar 1, 1987) McGraw-Hill

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<sup>1</sup> This book covers basic technologies (low end technologies)

<sup>2</sup> Mini-case studies on topical subjects, often relating to WATSAN infrastructure in developing countries