Environmental Management: Physical Science Fundamentals

IEST 7300

Course Overview
Important Notice

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Welcome

Welcome to the IEST7300: Environmental Management, Physical Science Fundamentals course!

The course is an introduction to the physical environment we live in – how it works, the way it can be measured and modelled, and how to interpret environmental data and statistics.

The subject introduces, at an elementary level, a number of core scientific disciplines, including physics, chemistry, mathematics & statistics, and physical geography. As such, the main body of the course has been developed by academics across the Faculty of Science, and by external practitioners from these disciplines, drawing on specialist knowledge in several areas of the physical environment. In addition, three of the 12 units have been developed by interdisciplinary practitioners from the Institute of Environmental Studies.

An understanding of the physical sciences underpins the management of our environment. Without an ability to understand the physics, chemistry and geography of environmental phenomena, management strategies would be little more than guesswork. Environmental managers therefore need, at the very least, basic literacy in physical and chemical science. This includes knowledge of:

1. Physical and chemical properties and their measurement
2. The scientific method and experimental design
3. Simple algebraic equations
4. The interpretation of environmental data and graphs
5. The basic environmental laws and processes operating in the natural world.

We hope you enjoy the course. If you have any general problems please contact the Course Coordinator A/Prof. Mark Diesendorf, by email m.diesendorf@unsw.edu.au or by phone on (02) 9385 5707. Specific scientific questions should be directed to the appropriate lecturer for the Units concerned. Questions of interest to the class should be posted on the Discussions page of the class Blackboard website accessed at MyUNSW
IEST 7300: Course Units, Dates and authors

On-campus classes are held on Tuesday evenings, 6.00-9.00 pm in Vallentine Annexe (H22), Room 121/122, with the exception of the physics laboratory class.

<table>
<thead>
<tr>
<th>Date</th>
<th>Unit</th>
<th>Title</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-7-12</td>
<td>1</td>
<td>Introduction to energy</td>
<td>A/Prof. Mark Diesendorf</td>
</tr>
<tr>
<td>24-7-12</td>
<td>2</td>
<td>Overview of classical physics and elementary algebra</td>
<td>A/Prof. Mark Diesendorf</td>
</tr>
<tr>
<td>31-7-12</td>
<td>3</td>
<td>Physics: Heat and thermodynamics I</td>
<td>Prof. Michael Burton</td>
</tr>
<tr>
<td>7-8-12</td>
<td>4</td>
<td>Physics: Heat and thermodynamics II</td>
<td>Prof. Michael Burton</td>
</tr>
<tr>
<td>14-8-12</td>
<td>5</td>
<td>Physics lab</td>
<td>Prof. Michael Burton</td>
</tr>
<tr>
<td>21-8-12</td>
<td>6</td>
<td>Green chemistry I</td>
<td>A/Prof. John Stride</td>
</tr>
<tr>
<td>28-8-12</td>
<td>7</td>
<td>Green chemistry II</td>
<td>A/Prof. John Stride</td>
</tr>
<tr>
<td>4-9-12</td>
<td>8</td>
<td>LECTURE BREAK</td>
<td></td>
</tr>
<tr>
<td>11-9-12</td>
<td>9</td>
<td>Introduction to data analysis and statistics</td>
<td>Larraine Becker</td>
</tr>
<tr>
<td>18-9-12</td>
<td>10</td>
<td>Total water management</td>
<td>Dr Crelis Rammelt</td>
</tr>
<tr>
<td>25-9-12</td>
<td>11</td>
<td>Green chemistry III</td>
<td>A/Prof. John Stride</td>
</tr>
<tr>
<td>2-10-12</td>
<td>12</td>
<td>Green chemistry IV</td>
<td>A/Prof. John Stride</td>
</tr>
<tr>
<td>9-10-12</td>
<td>12</td>
<td>Coastal management</td>
<td>Prof. Bruce Thom</td>
</tr>
</tbody>
</table>

A synopsis of each Unit is given on the next page.
## Synopsis of Units

<table>
<thead>
<tr>
<th>Unit/ date</th>
<th>Topic</th>
<th>Material covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 17/7</td>
<td>Introduction to energy</td>
<td>Basic physical principles of energy conversion, including 1st &amp; 2nd Laws of Thermodynamics. Energy efficiency, fossil fuels, renewable energy, electricity generation, balancing electricity supply and demand.</td>
</tr>
<tr>
<td>2. 24/7</td>
<td>Introduction to physics &amp; mathematical formulas</td>
<td>Some basic physical laws and principles used by environmental scientists. The scientific method. Design of measurement programs and limitations of technologies. Mathematical formulas. Manipulating data, experimental design and results.</td>
</tr>
<tr>
<td>3. 31/7</td>
<td>Heat &amp; thermodynamics I</td>
<td>Thermodynamic variables, absorption of heat, heat transfer processes, insulation</td>
</tr>
<tr>
<td>4. 7/8</td>
<td>Heat &amp; thermodynamics I</td>
<td>Thermodynamic variables, absorption of heat, heat transfer processes, insulation</td>
</tr>
<tr>
<td>5. 14/8</td>
<td>Physics laboratory</td>
<td>Laboratory demonstrations of basic physics relevant to Units 2, 3 &amp; 4. Distance students in Sydney are welcome to attend.</td>
</tr>
<tr>
<td>6. 21/8</td>
<td>An introduction to chemistry and the environment</td>
<td>The ‘language’ of chemistry. The potential impact of chemistry on the environment illustrated by Minamata case study.</td>
</tr>
<tr>
<td>7. 28/8</td>
<td>Heavy metals in the environment and the chemistry of the hydrosphere</td>
<td>Metals in the environment; their roles as essential elements and toxins. Chemistry of the hydrosphere – water chemistry – including fundamental properties such as acidity/basicity. Important processes that occur in water.</td>
</tr>
<tr>
<td>4/9/11</td>
<td>LECTURE BREAK</td>
<td></td>
</tr>
<tr>
<td>9. 18/9</td>
<td>Total water management</td>
<td>Key processes in natural water cycles and in water resources management. Impacts of human development on the water system and the importance of an integrated approach to water management.</td>
</tr>
<tr>
<td>10. 25/9</td>
<td>Organic chemistry and the environment and atmospheric chemistry</td>
<td>What are organic compounds? Deleterious effects of organic chemicals such as dioxins in the environment. Role of one class of organic compounds – chlorofluorocarbons – in development of the ‘hole’ in the ozone layer. Phytochemistry.</td>
</tr>
<tr>
<td>11. 2/10</td>
<td>Coping with the chemical age Current</td>
<td>Basics behind problems such as acid rain. Human reliance on chemicals and responses to adverse effects of chemicals use. Views of various groups. Search for alternatives. ‘Green’ chemistry</td>
</tr>
<tr>
<td>12. 9/10/</td>
<td>Coastal management</td>
<td>Physical processes leading to sea level change and landscape changes. Coastal environmental issues</td>
</tr>
</tbody>
</table>

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**Course overview** | **6**
About the academic staff

The cast in order of appearance:

A/Prof. Mark Diesendorf
Email: m.diesendorf@unsw.edu.au
Course coordinator
Mark Diesendorf is Associate Professor and Deputy Director of the Institute of Environmental Studies. His principal current research interests are interdisciplinary approaches to sustainable energy and transport. He is co-editor and principal author of the book *Human Ecology, Human Economy: Ideas for an Ecologically Sustainable Future* (1997) and author of *Greenhouse Solutions with Sustainable Energy* (2007) and *Climate Action: A campaign manual for greenhouse solutions* (2009). Before becoming an interdisciplinary teacher and researcher, Mark graduated BSc with first class honours in Physics from the University of Sydney and obtained his PhD in Applied Mathematics from UNSW, working on a topic in theoretical physics.

Prof. Michael Burton
Email: m.burton@unsw.edu.au
Presenter of Units on Heat and Thermodynamics
Professor Michael Burton is an astronomer in the School of Physics. His research concerns how stars form in the cold, dark molecular clouds of our Galaxy, making use of observations in the infrared and millimetre-wave bands. He is also a pioneer in the development of astronomy on the high Antarctic plateau, where the cold, dry conditions provide superlative conditions for many forms of observational astronomy. He teaches physics at all levels across the university, and has run several major outreach projects such as Science in the Pub and Astronomy on the Go.

A/Prof. John Stride
Email: j.stride@unsw.edu.au
Author/presenter of Units on Green Chemistry
John Stride came to UNSW in 2005 to take up a position in the School of Chemistry, having spent several years at large research labs in Europe focused on the study of the fundamental properties of materials using neutron scattering techniques. HOLDING A PhD in Chemistry from the University of East Anglia, the move to UNSW enabled him to reconnect with university-based research in Chemistry and to establish his own research group, which looks into new materials based upon molecular constructs. Current research areas of the Stride Group include molecule-based magnetic and highly porous
materials, molecular photovoltaics, photocatalysts and nano-materials. Many of these are aimed toward new technologies in the energy arena; porous materials are very important in gas capture and storage, organic photovoltaics promise novel and low-cost solar cells, whilst nano-materials such as graphene offer both extremely high surface areas and high charge mobilities, making it an ideal candidate for electronic devices and sensors.

Larraine Becker

Email: L.Becker@unsw.edu.au
Presenter of Unit on Data Analysis & Statistics

Larraine lectures and tutors for the School of Mathematics.

Dr Crelis Rammelt

Email: crelis.rammelt@unsw.edu.au
Presenter of Unit on Total Water Management

Crelis Rammelt is a lecturer at the Institute of Environmental Studies at UNSW. He holds a PhD degree in Environmental Policy and Management from UNSW. He co-founded the Arsenic Mitigation and Research Foundation, a Dutch-Bangladeshi organisation working on safe drinking water in rural areas, which formed the topic of his dissertation. Crelis graduated from the Delft University of Technology in the Netherlands on Integrated Water Management and People’s Participation in Bangladesh, and on Sustainable Product Development for Irrigation in Tanzania. After graduating, he worked as a lecturer at the Faculty of Technology, Policy and Management, where he pursued research in the role of technology in developing countries. He is currently researching water systems in the Asian context and supervising doctoral projects on water policy and management.

Prof. Bruce Thom PhD, FIAL

Author/presenter of Unit on Coastal Management

Formerly Vice-Chancellor of University of New England (1994-1996), Professor Thom has held positions such as Foundation Professor of Geography, Royal Military College, Duntroon (University of New South Wales, 1977-1984); Professor of Geography University of Sydney (1985-1993); and Pro-Vice-Chancellor Research, University of Sydney (1990-1993). He holds the title of Emeritus Professor from the University of Sydney. He was long-time Chair of the Coastal Council of New South Wales, and Chair of the State of the Environment Council for the Commonwealth Government, and is Visiting Professor of Geography at UNSW.
Aims

The essential aim of this course is to give students in environmental management a background in the physical sciences. Another aim is to provide case studies from the physical sciences that are applications to environmental protection and management.

An introduction is given to the physical environment over a range of phenomena. Specific topics to be discussed will be drawn from:

• The physical environment – the atmosphere, the ocean, the land surface, and the hydrological cycle.

• The chemical environment – chemicals and reactions in the environment, chemistry of pollutants and pollution, chemistry in the hydrosphere, biosphere, geosphere, and atmosphere, chemical toxicity and ‘green chemistry’.

• Physical processes in the environment, including those involving human intervention: energy production and use, heat and thermodynamics, coastal and beach processes, ocean currents, hydrology, water management, radiation.

• Chemical processes in the environment, including those involving human intervention: Chemical cycles in the atmosphere, toxicology, pollution, the ozone layer, carbon cycling, ocean nutrients and fisheries.

• Measurement and modelling of the environment: experimental design, interpretation and misinterpretation of field data analyses and statistics, global information systems, a basic understanding of environmental modelling.

• Mathematical formulas and elementary manipulation of simple algebraic equation.
Link to other courses in the MEM program

<table>
<thead>
<tr>
<th>Fundamental Knowledge Courses</th>
<th>Core Courses</th>
<th>Electives</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECOSYSTEM MANAGEMENT</td>
<td>FRAMEWORKS FOR ENVIRONMENTAL MANAGEMENT</td>
<td>Courses from:</td>
</tr>
<tr>
<td>ECONOMICS</td>
<td></td>
<td>IES</td>
</tr>
<tr>
<td>ENGINEERING</td>
<td>TOOLS FOR MANAGEMENT</td>
<td>Science</td>
</tr>
<tr>
<td>LAW</td>
<td></td>
<td>Engineering</td>
</tr>
<tr>
<td>PHYSICAL SCIENCE</td>
<td>ADDRESSING ENVIRONMENTAL ISSUES</td>
<td>Social Sciences</td>
</tr>
<tr>
<td>SOCIAL SCIENCE</td>
<td></td>
<td>Economics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Built Environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Law</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Studies</td>
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<td></td>
<td></td>
<td>etc.</td>
</tr>
</tbody>
</table>

This course is one of the six Fundamental Knowledge courses offered in the Master of Environmental Management program. The Fundamental Knowledge courses aim to help you develop basic ‘environmental literacy’ in key disciplinary areas. The MEM core courses offer an interdisciplinary approach to different frameworks for and tools of environmental management. The wide choice of electives enables you to design the program which best suits your needs.

An important aspect of the Fundamental Knowledge courses is that each will allow you to critically reflect on the contribution of a particular disciplinary arena – in this case the Physical Sciences.
About the units

Each of the units in the course constitutes a learning module with examples and exercises. You are expected to work through the units, one per week. Some of the topics are covered across several units.

The teaching and learning will be centred around weekly three hour meetings of the class for on-campus students and weekly discussions via the web for distance students. These meetings, and your independent study, will involve:

1. individual reading of the Units as preparation for weekly classes/web discussions
2. lecture presentations of key topics (on-campus students)
3. class discussions (face-to-face on campus and via the web for distance students)
4. examination of case studies
5. exercises in finding and evaluating information
6. explanation and criticism of articles
7. independent study for tutorial questions
8. preparation of assignments
9.

The learning program

Your learning in this course will be facilitated by the following activities:
• units which contain summaries of important concepts, assessment exercises, and lists of additional readings
• in-depth examination of real case studies
• preparation of assignments
• class discussions
• independent research and study

Studying in face to face (on campus) mode

Each class, with its unit of activities, will take place on a Tuesday evening from 6-9pm. The Course Co-ordinator will introduce the course. The authors of individual units will make lecture presentations and lead discussion of their own units.

Studying in distance mode

Studying as a distance student in the past used to be a lonely and isolating experience. Now that Internet access is commonly available, quality distance programs incorporate group learning by the use of a virtual classroom.

If you are a distance student on the MEM program you will be required to interact with your facilitators and fellow students using a virtual classroom using Blackboard software. Each week you will independently work through the unit of study in your study guide and then visit the virtual classroom to undertake learning activities with your class. The overall coordination of the ‘virtual classroom’ will be by the Institute of Environmental Studies (Mark Diesendorf) with the lecturers for the various units (as listed above) discussing your comments on the exercises or responding to your questions, for their topics.

To participate in your virtual class you will need regular and reliable Internet access. All you need to access the class is an appropriate Web browser, your student ID and zPass. Access your class website through MyUNSW.
Your learning resources

You will need

• This Course Overview
• Lecture notes for each Unit, downloadable from your class Blackboard website
• Access to the relevant publications that extend your reading beyond the set material

Some other useful resources

Reading material

An external reading list may be used to supplement some individual course notes. However, in many Units, the course notes provided will be largely sufficient for understanding the material covered each week. Details will be made clear in each Unit.

Internet information

There are thousands of Websites, discussion groups, mailing lists, newsletters and journals about the environment. Specific references will be given throughout the course.

Journals

Environmental matters have found their way into a great variety of academic journals. There are several devoted entirely to environmental themes, among these *Environment, Environmental Science & Policy, Environmental Science & Technology, Australasian Journal of Environmental Management* and *Global Environmental Change*. The journals *Science, Nature* and *New Scientist* are also useful to follow for current science issues relevant to environmental management. Popular magazines are *Ecos* (Australia), *Environment* (USA) and *The Ecologist* (UK).
Assessment

The assessment for this course has been designed to measure your achievement of the following learning outcomes.

Learning outcomes

After your study of this course you should be able to:

1. Give a basic explanation of the principal physical and chemical processes, including energy production and conversion in an industrial society.
2. Outline the key issues in managing energy, water resources, chemicals and the coastal zone.
3. Define environmental parameters, their related properties, their units, dimensions and techniques of measurement
4. Describe the essential elements of scientific methods, experimental design, and uncertainties, and appreciate their importance in environmental management.
5. Interpret the main points communicated in mathematical formulas, environmental data and statistical analyses
6. Communicate effectively with environmental scientists and modellers.
7. Recognise sound scientific practice and make good management decisions about the environment.

Your assessment tasks

The assessments for this course will comprise four take-home assignments and two short tests. They will be set by individual lecturers. The assignments will be of different lengths, depending on the number of Units taught by each lecturer.

The assessment tasks and associated weightings are listed in the table below.

For on-campus students the short tests will be held in class in the last half-hours of the appropriate lecture periods. The short tests will be emailed to distance students at the same times.
Assessment task | Lecturer & topic | Weight | Date due  
--- | --- | --- | ---  
Assignment 1 (take home) | A/Prof. Mark Diesendorf (2 units) Classical physics, energy, algebra | 25% | 14/8/2012  
Assignment 2 (take home) | Prof. Michael Burton (2 units) Heat & thermodynamics | 25% | 21/8/2012  
Assignment 3 (short test) | Larraine Becker (1 unit) Data analysis & statistics | 5% | 11/9/2012  
Assignment 4 (take home) | Dr Crelis Rammelt (1 unit) Water management | 5% | 25/9/2012  
Assignment 5 (short test) | Prof. Bruce Thom Coastal Management | 5% | 9/10/2012  
Assignment 6 (take home) | A/Prof. John Stride (4 units) Green chemistry | 35% | 19/10/2012  

Assignments

Each lecturer or the course convenor will inform you of the requirements for his/her assignments and requirements for submission. Some require hard copies (except for distance students) while others accept emailed submissions. Email attachments should have the name “FamilyName_IEST7300_AssN”, where N is the assignment number. Make sure that you receive an acknowledgment of receipt of electronic submissions by email within 24 hours.

Note

In your assignments, avoid using examples already set out in the class notes, unless you have been specifically asked to use these examples.

Participation

**On campus** classes will consist of lectures and associated discussions. Participants will be expected to contribute using their own knowledge and experience. Attendance and active participation is therefore an important part of the course. Students will not be marked on their participation, though attendance and such participation will clearly have
a strong influence on your success in carrying out the assessment tasks. Both on-campus and distance students may discuss the course via the Blackboard website.

**Distance** students will gain much by participation via the ‘virtual classroom’. It is an essential part of the course for distance students. Note however it is not ‘real time’ discussion, but rather that you will log on when it best suits you each week.