CVEN9872

Solid Waste Management

I. Introductory Notes 2016

University of New South Wales

Contents

1 Introduction

These introductory notes provide information on the learning and assessment approach for this subject.

Please take the time to read all these introductory notes, they have been prepared on the basis of common problems experienced by students in the past, and should therefore save you wasted time during the session. Please note:

- No campus study period is available for this course for distance students.
- All material will be provided on Moodle. There will not be any photocopies provided.

Notes and tutorial exercises will be issued during session.

Please refer to the News Forum, where announcements related to the course will be made. Please use the Q&A discussion to post questions. I will answer them and they can then be an archive for people who may subsequently have the same question.

In order to get a simulation of the internal students learning mode, I want distance students each week to:

Do the quiz that the internal students do (i.e. Stop the AV Echo recording; do the quiz in 10 minutes, then check your answers)

Watch the Echo recording of the lecture actively (stop the AV when a discussion point comes up; jot down a response; restart the AV)

Observe the discussion of the 4 nominated distance students on each week's question; make your own notes on this.

Only contribute to the discussion forum when nominated…so the forum does not get too crowded; and your input assists the remainder of the class.

Please retain a copy of everything you send to the University.

2 Subject Profile

2.1 Calendar Description

- 6 Units of Credit

No prerequisites

Characterisation of municipal solid waste; collection; transfer stations; waste minimisation and recycling; waste treatment, including size reduction, composting, waste to energy, emerging technologies; landfill disposal, including preparation of landfill management plans and operational aspects; introduction to planning of regional waste management systems.

2.2 Objectives

The objectives of this subject are to:

- Provide an appreciation of the management of solid waste in a systems context; ie to understand the nature of the various functional elements in regional waste management systems and the relationships among them, so that optimal systems can be designed.

- Provide an understanding of the characteristics of urban solid waste, and be able to predict the composition and quantities for any region.

- Be able to understand the data requirements for, and then be able to prepare concept designs of, common functional elements (e.g. transfer stations, composting facilites, waste to energy plants).

- Be able to prepare a solid waste Landfill Management Plan.

Students will be provided with the basic tools by way of audio/video streaming/podcasts of this year's lectures, and course notes and then will be expected to prepare workable solutions to assignment problems that have been drawn from a composite of real world problems.

Access to spreadsheet facilities (Excel) will greatly enhance the quality of assignment answers and understanding of the concepts in the subject.

2.3 Duration and Type of Instruction

CVEN9872 internal : One session, 3 hours a week; 2 hours lecture, 1 hour tutorial. No laboratory work. Site visits may be organized.

CVEN9872 distance : One session, distance. No laboratory. No campus study period.

2.4 Syllabus, Lecture Schedule & Study Guide

The lecture schedule for CVEN9872 is outlined in Table 2.1. Distance CVEN9872 students should use this as a guide for their own study program. The Guided Learning Unit (GLU) numbers do not follow the schedule, as the schedule varies each year related to guest lecturer availability and assignment topics; i.e. regard the GLU as a "textbook".

Table 2.1
Lecture schedule for Internal Students

WEEK	GLU	TOPIC
1	GLU01	Overview of Solid Waste Management Systems
2	GLU02	Waste characterization and modelling
3	GLU02	Waste characterization and modelling
4	GLU07	Waste to Energy
5	GLU05	Transfer Stations
6	GLU03	Waste minimisation
7	GLU04	Material recovery Facilities
8	GLU09, 10	Landfills
9		Site Visits to SITA facilities in Sydney. Meet at Barker Street Gate 14 Gatehouse at 11:50am for 12:00 departure on Thursday 22 September; returning to UNSW about 5:00pm http://www.facilities.unsw.edu.au/sites/all/files/KENC_Campus_July14.pdf
		Break
10	GLU06	Composting
11	GLU08	Mechanical Biological Treatment
12	GLU11	Landfill Gas
13		Review, questions

Lectures:
Noon – 3:00pm on Thursday in CE101

3 Assessment

3.1 Assignment and Examination Schedule

Assignment No.	Topic	Value	Due Date
1 int.	Site Visit/CDL report (internal only)	5%	Noon Tuesday 4 October 2016 via Turnitin in Moodle
1 dist.	UNSW Moodle participation (distance only)	10%	Throughout session; assessed end of Week 13
2	Waste incinerator review	20%	Noon Monday 19 September 2016, via Turnitin in Moodle
3	Weekly Quizzes (internal/distance)	5%	At the beginning of lecture each week; weeks 2-8; 10-12
	Exam	70%	During Session 2 Exam Period, 2 hour closed book (4 Nov – 22 Nov 2016 inclusive)

Assignments 1int. and 2 should be undertaken in self-selected groups up to a maximum of 3; distance students are encouraged to undertake a group assignment and to communicate via email and the “Assignment Group Fourm” on Moodle, only seen by members within their group; they can join with internal students if they wish.

The course coordinator will not act as an arbitrator in assignment groups. All members of a group will get the same mark. It is a requirement that groups demonstrate good project management skills to engage all members and to produce a collaborative final report.

Generally, marking schedules for each assignment are included with the assignments; these show where you should place emphasis. There may be conflicts between the due dates for CVEN9872 assignments and other course assignments – only students know these conflicts. Please advise the course coordinator by 12:30pm in the Week 2 lecture so that due dates can be adjusted if necessary. Due dates remain in place after 1:00pm in Week 2.

Group formation procedure:
Use the “Sign-up sheet for group selection” in the Assignments section in Moodle, to self select into groups of three. I will randomly allocate residual students to make up groups of three from Noon, Monday 8 August 2016.

3.2 Assignment Marking Criteria

Specific guidance on the value of components of each assignment is provided with the Assignments. It is difficult to be more precise than the guidance provided without being too prescriptive and taking away the opportunity for initiative from the student.

In general terms, all assignments will be assessed against the following criteria:

- Evidence of understanding of concepts; Exact correct numerical answers will rarely be required or be appropriate, but gross numerical errors which are left unchecked, and which indicate that the student does not understand the concepts, will be marked down heavily.
- Ability to apply concepts to real world problems, and to make judgements based on incomplete data and the need to simplify systems in order to develop solutions.
- Clarity of description, explanation and attention to the focus of the assignment.
- Ability to structure an assignment logically and limit it to a reasonable length.

Please complete and attach the assignment cover sheet to each completed assignment.

3.3 Assignment Policy & Penalties

Extensions of time will only be given in the case of medical problems or personal emergencies, and only if requested prior to the due date. Work and other extra curricular activities are not valid reasons for extensions of time without penalty. If a personal emergency (not a peak in work load) arises that may cause a delay in completing or sending the assignment, call the course co-ordinator as soon as possible. He may ask you to complete a Special Consideration form (see below for details).

A penalty of 10% of the total mark for the assignment may be applied to assignments arriving after the due time/date specified in the Assignment Schedule.

A further 10% penalty for each additional late week may apply.

Referencing must be completed using the Harvard system. Failure to do this may result in the assignment being returned to be resubmitted, incurring late penalties.

Students should take note of the general guidelines provided in these Introductory Notes and any special requirements listed in individual assignments.

Each Group should only submit one assignment by one of the team via Turnitin. The first assignment submitted will be the one marked. Ensure all group members are satisfied with the assignment before one person submits it.

3.4 Exam

The exam will be a 2 hour closed book exam during the normal exam period. The questions will generally be similar to the shorter questions in assignments and the exercises in class and the on-line discussion forum. There are no previous exams available. The Exam date is set by Exams Branch, and is confirmed in October. You can access the time and date of the exam from your MyUNSW. You must be available to do the exam at the specified time, which will be in the Exam Period (see above).

Final Examination
All students are expected to sit their final examination at the UNSW Kensington campus. For more information on exams such as approval guidelines to sit the final examination via distance (if required), please see the link below:
http://www.engineering.unsw.edu.au/civil-engineering/resources/exam

A supplementary exam will only be given in "WC" cases; ie there was a documented illness or misadventure on the day of the exam. You need to complete a Special Consideration form. See details at:

https://my.unsw.edu.au/student/atoz/SpecialConsideration.html

3.5 Other School information

COURSE EVALUATION AND DEVELOPMENT

The School of Civil and Environmental Engineering evaluates each course at selected times (normally every second offering, so that students do not suffer from "survey fatique") it is run through (i) the UNSW Course and Teaching Evaluation and Improvement (CATEI) process, and (ii) Focus Group Meetings.

As part of the CATEI process, your student evaluations on various aspects of the course are graded; the Course Coordinator prepares a summary report for the Head of School. Any problem areas are identified for remedial action, and ideas for making improvements to the course are noted for action the next time that the course is run.

COMMON SCHOOL INFORMATION

Common School information may be found at:

http://www.engineering.unsw.edu.au/civil-engineering/resources/academic-advice

The **Common School Information** site has information on the following:

1. **Dates to Note** - important dates relating to enrolling and disenrolling, and a University website (via MyUNSW) with a calendar of other important UNSW dates (semester dates, recess weeks, stuvac dates and exam periods).
2. **School Contacts**
   i. for enrolment or timetable difficulties,
   ii. referral chain of contacts for course difficulties: Course Coordinator/Lecturer → Year Coordinators → Grievance Officer,
   iii. Advanced Standing, and
   iv. Mentoring.
3. **Course Requirements**
   i. attendance at lectures, tutorials and laboratory classes,
   ii. participation in tutorials, and
   iii. completion of assessment work.
4. **Notes on Assessment**
   plagiarism (with link to UNSW Learning Centre web site on plagiarism),
   i. keep a copy of written submissions,
   ii. submitting assignments, and
   iii. late submissions (obtaining extensions and special consideration)

5. **Supplementary Exams**
   – includes link to School website with School policy on supplementary exams.
   i. Special Consideration – includes link to UNSW website (New South Q) for downloading forms, requirements for lodging special consideration forms.
6. **Solutions to Problems – Troubleshooters**
   i. Learning Centre,
   ii. student counsellors, and
   iii. student support services.
7. **CEVSOC** – student committee membership and link to (unofficial) student CEVSOC website.

4 Learning Methods

4.1 Approach

Students have four major resources to assist their learning:

- The Coursenotes provided in the Moodle website (see UNSW home page) and the suggested reference, which should be studied actively. Important exercises will be set for distance students, and will be discussed in class.

- A range of supplementary learning aids, such as the audio/video of the lecture give via Echo and associated Powerpoint slides to be placed on Moodle.

- The lending facilities of the Library and advice from the Course Lecturer.

- Other students currently undertaking the course distancely. Contacts should be established early in the course, or via the discussion on Moodle for the course. Your colleagues are an invaluable source of assistance and should continue to be so after completion of the course.

4.2 Staff

The subject co-ordinator and principal lecturer is:

Stephen Moore
Senior Lecturer in Waste Management

Room 308 Civil Engineering.
Email : S.Moore@unsw.edu.au

Course Administrators:

CVEN.Enquiries@unsw.edu.au

All academic enquiries and questions relating to Coursenotes and assignment technical aspects should be directed to Mr. Moore.

4.3 Texts and References

4.3.1 Texts and references

Refer to the readings in each weekly topic.

4.3.2 Relevant Journals

Technical papers and news items in the field of solid waste management are provided in the following:

- Waste Management & Research, the Journal of the International Solid Waste Association, see: http://www.iswa.org/

- Newsletters of the Waste Management Association of Australia, see: http://www.wmaa.asn.au/

4.3.3 UNSW Library

Go to the introductory pages on the library web site, and work your way through ELISE.

http://www.library.unsw.edu.au/servicesfor/PGandH.html

Distance students should read the following pages for their borrowing procedures:
http://lib.unsw.adfa.edu.au/callslips.html

http://lib.unsw.adfa.edu.au/servicesfor/off-campus.html

5 Guidelines for Assignments

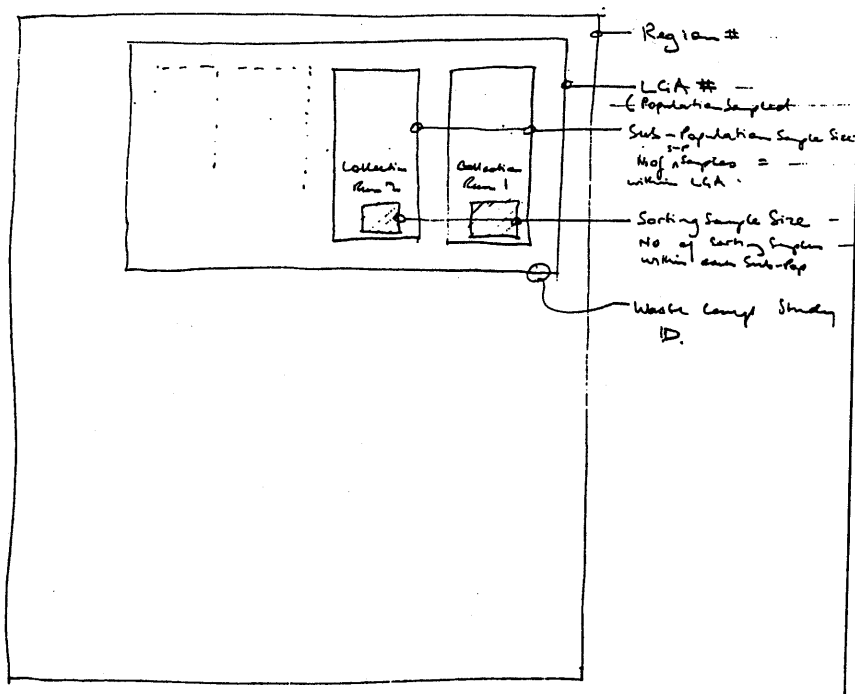
Assignments will consist of calculations or short reports or both. Guidelines on the presentation of calculations and reports are provided in 5.1 and 5.2, and guidance on more general issues of preparing assignments are provided in Section 5.3.

5.1 Calculations Format

Calculations should be undertaken on squared or blank paper. An example recommended format is shown in Figure 5.1. Note the following suggestions (most assignments will have part of the mark on presentation);

- Provide a table of contents for calculations
- Title block on each page showing:
  - Assignment No., part
  - Calcs By
  - Date
  - Sheet No.
- List data and assumptions at start of each section of calculations.
- A reference list on the right hand side showing sources of data, cross reference to other parts of the calculations.
- Use headings and section numbers.
- Use diagrams and graphs where possible.
- Use a sharp HB or B pencil.
- Spread out your calc's
- Use words to guide the checker through the workings.
- Use tables to summarise calculations and outcome of calculations.
- Use spreadsheets and tabular calculations where any repetitive calculations are required.

WASTE COMPOSITION : Real World Model :



Could also be appropriate for 2 or 3 .. LGAs as the Population Sampled for one Waste Comp Study ID

Waste Comp Study ID	Region	LGA	Sub-Popl^n Sample Size (Popl^n)	No of SP Samples in LGA (No)	Sorting Sample Size (kg)	No of Sorting Samples per SP (No)	
2001	203	1234	5000	2	200	4	The comp data would be for whole region in WSCD Relⁿ
2001	203	1235	5000	2	200	4	
2002	203	1234	5000	2	200	4	Composition Data provided for each LGA in WSCD Relⁿ
2003	203	1235	5000	2	200	4	

FIGURE 5.1

5.2 Reports Format

Where an assignment requires presentation in the form of a report, the following should be included:

- Title Page
- Table of contents
- Page numbers
- Headings, sub-headings and sub-sub headings, all numbered
- References, providing full details in a List of references or the back of the report. Reference all data
- Appendices to include:
  - copy of the question (the Brief)
  - detailed calculations and workings (summarise in tabular form in the report).
- List points with brief expansion underneath the point, rather than provide verbose formal descriptions. e.g. use the following format instead of burying the important points in pages of text:

"The three factors governing the performance of incineration systems are:

- Time: the residence time of solids and gases at the elevated temperature affects destruction efficiency.
- Temperature: high temperatures lead to improved destruction efficiency.
- Turbulence: highly turbulent well mixed reactors achieve better destruction efficiencies."

- Provide a summary
- Make assumptions clear and explicit.
- Typed reports are required.

See the example in following pages.

5. INCINERATION EMISSION UPGRADING

5.1 TYPES OF EMISSION

Emissions from waste incinerators include a range of gaseous products mainly comprising:

- **particulates.** These include material that affects visibility and which in conjunction with acid gases (notably sulfur dioxide) cause acid smogs. These are effectively removed by standard processes such as electrostatic precipitators. Particulates are of concern because they tend to have heavy metals, dioxin etc attached to them. The larger sized particulates are easy to remove but the finer sizes are more difficult, usually requiring a fabric filter, or 'baghouse'.

- **acid gases.** Sulfur oxides, fluorides (as HF), and hydrochloric acid are all very effectively removed by alkali (lime) scrubbing. Of greater concern are the nitrogen oxides formed by combination of atmospheric nitrogen and oxygen at high temperatures. Typically about 1% of total oxygen and nitrogen is converted to nitric oxide (NO), the precursor of nitric acid, at high temperatures. Nitric oxide is rapidly converted in the atmosphere to nitrogen dioxide (NO_2 or its dimer N_2O_4) and collectively they are referred to as nitrogen oxides or NO_x. Nitrogen oxides are involved in complex photochemical reactions, particularly in the presence of hydrocarbons, which produce the familiar brown haze or photochemical smog.

  Nitrogen oxides can be reduced catalytically with ammonia (NH_3) to produce harmless nitrogen gas and water. Current advanced catalytic treatment can reduce NO_x to levels below 50 mg/m^3, a level widely considered to have minimal environmental impact, but there are major cost penalties for achieving such stringent levels. There are a range of techniques that can be used to minimise NO_x formation in stationary combustion sources.

- **Pyrolysis products.** Pyrolysis products include incompletely combusted material, elemental carbon (regulated as a particulate component), and hydrocarbons (volatilised unburnt material or complexly rearranged organic material such as toxic polyaromatic hydrocarbons). The latter are low to medium temperature byproducts also produced in backyard incinerators, by barbeques, and by wood fires. Increasing temperature and oxygen availability, for example by providing multichamber sequential burning effectively overcomes these problems. Of greater concern is the production of fused chlorinated aromatic hydrocarbons, often referred to collectively as dioxins or furans. Technically they are mainly chlorinated dibenzodioxins and chlorinated dibenzofurans, usually expressed as toxic equivalents of 2,3,7,8-tetrachloro-p-dibenzodioxin.

  Dioxins and furans can be removed, using powdered coke (carbon) in which material is oxidised to environmentally acceptable carbon dioxide, water, and chloride ion. Trace residues can then be removed by scrubbing.

- **Heavy metals.** Heavy metals cannot be transformed to innocuous gaseous products. However they can be effectively removed from flue gases using conventional dry scrubber and baghouse. The common toxic heavy metal mercury, cadmium and lead, are a typical waste component (cadmium and lead for example are components of batteries) and the important overall strategy in waste disposal management is to remove them from the waste stream before they are incinerated (or landfilled). If this can't be achieved then it is necessary to effectively immobilise them in the ash, that is avoid their volatilisation or movement in leachate.

As well as specifying emission levels there are a wide range of caveats on the construction, lay-out and operation of waste incinerators, including operating furnaces at pressures below atmospheric pressure, fire detection requirements, storage of explosive materials, and storage of liquids. Combustion controls include optimum operating requirements, temperatures of at least 850°C for domestic wastes, sewage sludge, and hospital wastes, (with other materials requiring a minimum temperature of 1200°C), degree of mixing (homogenous mixture), gas contact time (2 seconds) and minimum oxygen supply (3 per cent in exhaust gas for exclusively liquid feed; 6 per cent for all other feedstock). There are caveats for allowing different operating conditions for installations in service where requirements can be shown to be met for emissions of polycyclic aromatic hydrocarbons, polyhalogenated dibenzodioxins, polyhalogenated dibenzofurans, and polyhalogenated biphenyls.

There are specified afterburner requirements, and requirements for use of automated incineration appliances, notably good temperature controls, and controls over excursions in carbon monoxide and flash levels, and shut down requirements. Tables 5.3 and 5.4 summarise the German standards.

On February 11 1991, the United States EPA issued the final New Source Performance Standards (NSPS) applicable to municipal waste combustors (MWCs) with unit capacities above 250 tons per day that combust residential, commercial and institutional discards. Combustion of industrial, medical, and construction waste is not covered by the NSPS. The NSPS emission limits are shown in Table 5.

Like the German regulations, the US regulations also establish requirements for good combustion practices and emissions and load monitoring. The specified combustion controls are intended to ensure that organic emissions, particularly dioxins/furans, are minimised on a continuous basis:

- Maximum load level must be demonstrated during the required dioxin/furan performance test.
- The maximum allowable temperature as measured at the particulate matter control device inlet must be demonstrated during the dioxin/furan performance test.
- A Carbon Monoxide (CO) emission limit is established according to the type of incinerator, as set forth in Table 5.6.

5.4 FUTURE AUSTRALIAN STANDARDS

Although it can confidently be expected that New South Wales and Australian standards for emissions from municipal solid waste incinerators will be revised in the foreseeable future, unfortunately it is not possible to be definitive on what standards will be adopted.

There are three possible approaches to standard setting:

- environmental carrying capacity, which is risk based and requires a large database. However it has inherent uncertainties which lead to problems with public credibility
- materials flux analysis, which is more pragmatic and relatively inexpensive, as adopted by the Swiss
- technology capability, which is the best available technology (BAT) or best available technology economically available (BATEA), of which the latter is the most likely approach to be used in a country such as Australia.

Discussions with EPA to date have indicated that they favour modelling the new NSW standards on the current German emission standards because they represent the most stringent of world standards.

5.3 Learning Centre of UNSW Guidelines

See the guidelines at http://www.lc.unsw.edu.au/