650.463 Food Process Engineering

This is a Part IV elective course for the B.Eng. (Chemical & Materials Engineering, *C&M*) and B.Tech (Biotechnology, *BioT*) courses given in Semester I 2000.

Staff

Course Co-ordinator : Associate Professor Dong Chen *XDC* [C&M : E-mail d.chen*].

Principal Lecturers

Dr. Andrew Russell	*AB*R	[C&M: *E-mail* a.russell]
Dr. Laurie Melton	*LM*	[Director of Food Science, Chemistry : *E-mail* l.melton]
Dr. Ian Wilson	*DiW*	[Visiting Senior Lecturer, Chemical Engineering, University of Cambridge/C&M : *E-mail* ian.wilson]

Guest Lecturers

Dr. Byrony James	*BJ*	[C&M: *E-mail* b.james]
Dr. Mohamed Farid	*MMF*	[C&M: *E-mail* m.farid]
Dr. Paul Kilmartin	*PK*	[Food Science, Chemistry: *E-mail* p.kilmartin]
Dr. Ralph Stevenson	*RS*	[Food Science, Chemistry: *E-mail* r.stevenson]
Dr. David Pearce	*DP*	[NZ Dairy Research Institute, Palmerston North]

Programme

44 × hours lectures	See Synopsis & Schedule
16 × hours of tutorials	See Synopsis & Schedule
3 × laboratory sessions	XDC will issue instructions about laboratory sessions

Objectives

This course has been substantially revised and restructured from its predecessor, Advanced Biochemical Engineering, given in 1999: we hope to presents a novel and forward-looking approach to the subject matter and the challenges involved in food process engineering. Our initial objectives are for students

(a) To understand the engineering basis of food processing and its links with the relevant sciences.

(b) To understand the relationships between food quality (composition, function and flavour) and processing – particularly microstructures.

(c) To appreciate the particular demands of the food processing environment, with particular attention to hygiene and sterility.

(d) To become familiar with a range of topics in food processing, with particular reference to the existing NZ food industries and emerging technologies.

* *All e-mail addresses are @auckland.ac.nz unless otherwise specified*

Assessment

Final Exam	50%	
Assignments	40%	[Written work]
Project	10%	[Written and oral presentations]

ALL aspects of the course must be satisfied.

Teaching Materials

Lecture Notes will be distributed in the classes. Example Problem Sheets and Assignments will be distributed in the various tutorial classes. Some of these materials will be posted in Adobe Acrobat .pdf format on the C&M website shortly after each lecture. Note that all such Teaching Materials are copyright protected.

No one text exists for this course. The principal text for the course, which will be referred to extensively in the quantitative sections, is

Singh, R.P. and Heldman, D.R. (1993) *Introduction to Food Process Engineering*, Academic Press, ISBN 0 126 463 816.

Another introductory text, more suitable for chemical engineers, is

Fryer, P.J., Rielly, C.D. and Pyle, L. (1997*) Chemical Engineering for the Food Industry*, Blackie, ISBN 0 412 495 007

The following text is highly recommended reading, particularly for those likely to be employed in the food sector. It can be obtained from www.Amazon.com; a copy is to be made available on restricted loan from the Engineering Library.

Aguilera, J.M. and Stanley, D.W. (1999*) Microstructural Principles of Food Processing and Engineering*, Aspen, ISBN 0 834 212 560. [B]

The following reference texts provide more substantial coverage of particular sections of the course material.

Garbutt, J. (1997) *Essentials of Food Microbiology*, Arnold, ISBN 0 340 677 015 [A, D, E]

Steffe, J.F. (1992 -1st edn : 1997 - 2nd edition) *Rheological Methods in Food Process Engineering*, Freeman Press, MI [B]

Holdsworth, D (1997) *Thermal Processing of Packaged Foods*, Chapman & Hall, London, ISBN 0 7514 0375 X [D]

Lewis, M.J. (1990) *Physical Properties of Foods and Food Processing Systems*, Ellis Horwood [B, E]

Jowitt, R. (1983) *Physical Properties of Foods*, Elsevier Applied Science [B]

EHEDG Guidelines and Test Methods (1997) – reprints *from Trends in Food Science and Technology*, publ. Elsevier Trends Journals, Cambridge UK. [D]

Useful Websites include

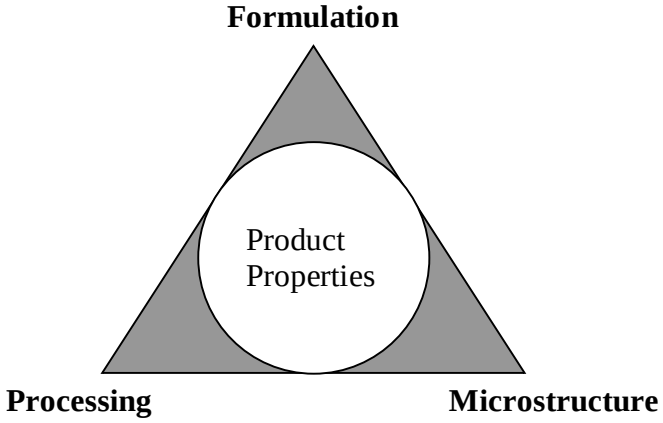
sci.mond.org – Society of Chemical Industry – Food Engineering Group
www.ift.org – Institute of Food Technologists

Journals with a consistent coverage of food process engineering topics

J. Food Engineering
J. Food Process Engineering
J. Food Science
Starch/Stärke
Transactions of the IChemE Part C : Food and Bioproducts Engineering

Synopsis and Schedule

Food materials are inescapably complex; even our sense of taste is a complex response to texture, chemical (smell) and chemical (reaction – taste bud) properties. Both the textural and chemical properties of a food product are related to its formulation (ingredients) and processing history, via the *microstructure* of the material. The three are intimately related, as suggested by this diagram:



The course structure is

A Introduction – the Micro-World of Food

The building blocks of food – a brief introduction to food composition, chemistry and physics from staff in Food Science, with some focus on the measurement of mechanical and chemical changes in foods using thermal analysis.

B Microstructure Engineering of Foods

A look at the impact of processing techniques and the structures they impart. How to study microstructures. How structures in turn affect processing (example : rheology).

C Moving Molecules and Energy Across Interfaces

Heat and Mass transfer, with and without reaction – cooking, drying, freezing and membrane separations

D The Processing Environment – Safety = Profitability

Death to undesirable microbes and generating hygienic processes.

E Applications

A mixture of existing NZ industry topics and emerging technologies.

F Project

G Professional Communication and Job Application

Approximate Course Schedule

M 9 - 3.405: Tu 10 (tutorial) 3.406: Tu 9 - 3.406 : W 9 - 3.406 : Th 10 - 3.406

Date	*#*	*Staff*	*Topic*
M Feb 28	L1	XDC *et al.*	Introductory Lecture
Tu Feb 29	T1	*tutorial*	*Activity 1 – Analysis of a Food Product : Ingredients*
Tu Feb 29	L2	LM	A1 Foundation in Food Science
W Mar 1	L3	LM	A1 Foundation in Food Science
Th Mar 2	L4	LM	A1 Foundation in Food Science
M Mar 6	L5	LM	A1 Foundation in Food Science
Tu Mar 7	T2	*tutorial*	*Activity 2 – Analysis of a Food Product : Structure*
Tu Mar 7	L6	RS	A2 Food Flavour & Analysis
W Mar 8	L7	RS	A2 Food Flavour & Analysis
Th Mar 9	L8	ABR	B1 Generating Structure – Crystallisation
M Mar 13	L9	ABR	B1 Generating Structure – Emulsification
Tu Mar 14	T3	*tutorial*	*Activity 3 – Analysis of a Food Product : Process*
Tu Mar 14	L10	ABR	B1 Generating Structure – Foaming
W Mar 15	L11	BJ	B2 Exploring Structure - Techniques
Th Mar 16	L12	ABR/DiW	B3 Structure in Action - Rheology
M Mar 20	L13	ABR/DiW	B3 Structure in Action - Rheology
Tu Mar 21	T4	*tutorial*	*Examples Class - Rheology*
Tu Mar 21	L14	ABR/DiW	B3 Structure in Action - Rheology
W Mar 22	L15	ABR/DiW	B3 Structure in Action - Rheology
Th Mar 23	L16	XDC	C1 Basics of Heat Transfer & Thermal Properties
M Mar 27	L17	XDC	C1 Basics of Heat Transfer & Thermal Properties
Tu Mar 28	T5	*tutorial*	*Examples Class – Heat Transfer (1)*
Tu Mar 28	L18	XDC/MMF	C2 Freezing and Thawing
W Mar 29	L19	XDC	C3 Basics of Mass Transfer
Th Mar 30	L20	XDC	C3 Basics of Mass Transfer
M Apr 3	L21	XDC	C4 Deyhydration
Tu Apr 4	T6	*tutorial*	*Examples Class – Heat Transfer (2)*
Tu Apr 4	L22	XDC	C4 Deyhydration
W Apr 5	L23	XDC	C4 Deyhydration
Th Apr 6	L24	XDC	C4 Deyhydration
M Apr 10	L25	XDC/DiW	C4 Membrane Separations
Tu Apr 11	T7	*tutorial*	*Examples Class – Dehydration*
Tu Apr 11	L26	XDC/DiW	C4 Membrane Separations
W Apr 12	L27	XDC/DiW	C5 Combined Heat and Mass Transfer
Th Apr 13	L28	XDC/DiW	C5 Combined Heat and Mass Transfer

Date	*#*	*Staff*	*Topic*
M May 1	L29	XDC/DiW	C5 Combined Heat and Mass Transfer
Tu May 2	T8	*tutorial*	*Examples Class – Membrane Separations*
Tu May 2	L30	DiW	D1 Hygiene, Sterility and Death
W May 3	L31	DiW	D1 Hygiene, Sterility and Death
Th May 4	L32	DiW	D2 Fouling and Cleaning
M May 8	L33	DiW	D2 Fouling and Cleaning
Tu May 9	T9	*tutorial*	*Examples Class – Hygiene*
Tu May 9	L34	DiW	D3 Sterilisation and Aseptic Processing
W May 10	L35	ABR	E1 Dairy Processing
Th May 11	L36	ABR	E1 Dairy Processing
M May 15	T10	XDC *et al.*	*F - Project Seminar (1)*
Tu May 16	T11	XDC *et al.*	*F - Project Seminar (2)*
Tu May 16	L37	ABR	E1 Dairy Processing
W May 17	L38	DP	E2 Advanced Dairy Processing
Th May 18	L39	MMF	E3 Refrigeration
M May 22	T12	XDC *et al.*	*F - Project Seminar (3)*
Tu May 23	T12	XDC *et al.*	*F - Project Seminar (4)*
Tu May 23	L40	DiW	E4 Sensors and Instrumentation
W May 24	L41	DiW	E4 Sensors and Instrumentation
Th May 25	L43	MMF	E5 Microwaves
M May 29	T13	XDC *et al.*	*F - Project Seminar (5)*
Tu May 30	T14	XDC *et al.*	*F - Project Seminar (6)*
Tu May 30	L44	DiW	E6 Baking or E7 Fruit and Flavour Extraction
W May 31	T15	XDC *et al.*	*F - Project Presentations (5)*
Th June 1	T16	XDC *et al.*	*F - Project Presentations (6)*

Assignments 1 based on the tutorials in Section A/B
2 based on Section B
2 based on Section C
1 based on Section D

Project

Details of the project will be revealed in May. The project will feature

(a) Working in groups of 2 or 3, where there is at least one B.Tech and one B.Eng student in each group. Each student will be required to generate an individual report.

(b) An oral presentation, to be delivered in a set of class seminars.

(c) A poster presentation : the poster session will be combined with a social event and there will be prizes for the best posters.