PRIFYSGOL glyndŵr UNIVERSITY

MODULE SPECIFICATION FORM

Module Title: **Advanced Green Chemistry**	Level: 6	Credit Value: 20

Module code: SCI617	Cost Centre: GAFS	JACS3 code: F100

Trimester(s) in which to be offered: 1	With effect from: September 2014

Office use only: To be completed by AQSU:	Date approved: July 2014 Date revised: - Version no: 1

Existing/New: New	Title of module being replaced (if any):

Originating Academic Department: Chemistry	Module Leader: Dr. Ian Ratcliffe

Module duration (total hours): 200 Scheduled learning & teaching hours 60 Independent study hours 140	Status: core/option/elective (identify programme where appropriate): Core

Programme(s) in which to be offered: BSc (Hons) Chemistry with Green Nanotechnology	Pre-requisites per programme (between levels): None

Module Aims:

- Explore current and anticipated EU and global regulation in the chemical industry and its impact.
- Develop a 'hands on' knowledge of green catalysis and green solvents.
- Consider process/chemical engineering aspects: reactor design and reaction scale-up issues.
- To build subject specific communication skills to facilitate professional interaction with industrialists, academics and the general public.

Intended Learning Outcomes:

At the end of this module, students will be able to ...

1 Critically evaluate given experimental protocols / data in terms of Green Chemistry metrics / "greenness". (KS5, KS10)
2 Formulate with justification experimental methods for "greening" a traditional chemical reaction *e.g*. a Friedel-Crafts acylation or a natural product extraction. (KS3)
3 Assess consequences of revised formulations on regulatory compliance (KS5, KS10)
4 Develop solutions to common issues around scale up of lab-scale chemistry to plant-scale chemistry *e.g*. Scale up of waste, inappropriate solvent volumes, large scale purification issues (chromatography). (KS3)
5 Propose new reactor designs/experimental techniques for large scale production. (KS3)
6 Acquire complex scientific information from academic and industrial subject specialists and disseminate to peers and non subject specialists in a professional manner.(KS1, KS3, KS6)

Key skills for employability

1. Written, oral and media communication skills
2. Leadership, team working and networking skills
3. Opportunity, creativity and problem solving skills
4. Information technology skills and digital literacy
5. Information management skills
6. Research skills
7. Intercultural and sustainability skills
8. Career management skills
9. Learning to learn (managing personal and professional development, self management)
10. Numeracy

Assessment:

Assessment 1. Students will be given a literature based research task concerned with assessment of a small number of experimental scenarios. Assessment will be based on a report exploring the 'greenness' of the experiments and potential ways for this to be improved.

Assessment 2. The student and tutor agree a case study with a commercial perspective such as reactor design, process scale-up *etc* which is investigated by the student. Assessment is by means of a presentation which should incorporate information sourced from commercial / industrial contacts.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting	Duration (if exam)	Word count (or equivalent if appropriate)
1	1-3	Report	50%		2000
2	4-6	Presentation	50%	20 mins	

Learning and Teaching Strategies:

The taught material delivered by lectures and reinforced by guided independent study will be extensively developed by consideration of case studies of, for example scale up issues and reactor design. Confidence in discussing technical information will be enhanced by external visits *e.g.* to appropriate trade exhibitions and commercial premises. Critical review of appropriate scientific literature as directed by tutors will include group work and will inform students of the latest developments in the field.

Syllabus outline:

Regulation in the chemical industry: *e.g.* REACH, ISO14001
Alternative solvents and catalysts, *e.g.* Ionic liquids, biphasic systems - building on from earlier module.
Reactor design *e.g*. spinning disc reactors/microreactors to overcome production issues.
The importance of engaging with all stakeholders in the chemical industry *e.g*. Overcoming "chemophobia" in the end-user.

Bibliography:

Essential reading:

Lancaster M. (2010) *Green Chemistry: An Introductory Text (*2nd Ed.), Cambridge: RSC Publishing.

Other indicative reading:

Anastas, P.T. and Warner, J.C. (2000) *Green Chemistry: Theory and Practice*, New York: Oxford University Press.

Clark, J.H and Macquarrie, D. J. (Eds) (2002) *Handbook of Green Chemistry and Technology*. Oxford: Blackwell Publishing.

Govind, R. (2015) Products and Process Design: Sustainable Manufacturing. McGraw-Hill Professional

Online resources: - online access via Science Direct

Journal of Cleaner Production
Journal of Molecular Liquids
Focus on Catalysts
Applied Catalysis A: General
Catalysis Today