

Programmatic Review of the School of Mechanical, Electrical & Process Engineering (Phase 2)

Department of Process, Energy & Transport Engineering

22nd – 23rd April, 2015

Energy Engineering Programmes Reviewed:

Bachelor of Engineering (Honours) in Sustainable Energy Engineering (NFQ L8)

Higher Certificate in Engineering in Building Services Engineering (Embedded Award, NFQ L6)

Bachelor of Engineering in Building Services Engineering (NFQ L7)

Bachelor of Engineering (Honours) in Building Energy Systems (NFQ L8)

Certificate in Plant and Piping Design (Special Purpose Award, NFQ L7, 55 ECTS Credits)

Energy Engineering Sub-Panel:

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Mr Shane Merrit, SEE, Year 4
Mr Darragh O'Reilly, SEE, Year 4
Mr Garry Spitere, BES, Year 4
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Graduates:

Mr Colin Moynihan, Airflow Services, Little Island, Cork (Graduate of BIS/BES)
Ms Kerstin O'Connor, Sustainable Energy Engineer, Sunsource Energy & Co., Cork (Graduate of SEE)
Mr Adam O'Donovan, Postgraduate PhD Researcher (Graduate of SEE)
Mr Alan O'Flynn, BAM, Cork (Graduate of BIS/BES)

Employers/Industry:

Mr Richard Linger, Technology Gateway Manager, Nimbus Research Centre, CIT (SEE)
Mr Conor O'Driscoll, EDC, Blackpool, Cork (BIS/BES)
Mr Mark Ryan, PM Group, Mahon, Cork (BIS/BES)

Findings of the Energy Engineering Sub-Panel

1. Overall Recommendations

1. The Panel would like to **commend** the programme teams on their open and transparent engagement with the review process and on their hard work, efforts and enthusiasm evident in relation to the delivery of the programmes. The panel also **commends** the overall quality of the documentation presented in relation to the programmes and the associated modules.
2. Following a review of programme documentation and discussions with the programme teams and with learner, graduate and employer representatives, the Panel **approves** the changes to programmes and modules proposed by the department overall and **recommends to Academic Council that the Energy Engineering Programmes listed above be revalidated** for a period of five years or until the next Programmatic Review, whichever is sooner, subject to implementation of any panel requirements and successful completion of the module moderation process, and with all due regard for a timely implementation of the individual panel recommendations set out below.

2. Relevance of Programmes and Demand for Graduate Profile

Findings and Observations

Enrolments and Recruitment (BIS / BES / SEE)

Programme entry statistics were discussed at length, as it was noted that all degrees were suffering from reduced recruitment year on year. This issue was of major concern to the programme boards of the BIS / BES programmes in particular.

The BEng (Hons) in Sustainable Energy Engineering ran for the first time in 2008/09 and went from a peak enrolment of 59 entrants in 2011/12 to 26 in 2013/14 and 2014/15. The programme team deemed the high enrolments of the early years to be the result of a degree of initial 'hype'. Entry appears to have stabilised at around 26 in recent years. In addition, 10 – 12 students per annum transferred into the final year of the SEE degree from the L7 in Civil Engineering. Students transferring from other Engineering disciplines were initially required to enter into Year 3 of SEE, but a special 1-year Bridging Studies programme has now been put into place enabling transfer students to enter Stage 4.

A more significant fall-off has been experienced by the Building Services Engineering and Building Energy Systems programmes. The Level 7 BEng in Building Services Engineering, first validated as a Diploma over 25 years ago, had annual intakes of 30 – 40 entrants in the '90s and early '00s, with a small dip only in 2003. However, the economic downturn and contraction of the building industry in 2008 brought a dramatic decline in take-up, with 3 new entrants only in 2012/13, 6 entrants in 2013/14 and no new enrolments in the current academic year. There currently remain 2 students in Stage 2 only.

First year entry into the ab-initio 4-year BEng (Hons) in Building Energy Systems, which commenced in September 2012 as a 'ladder conversion', was weak from inception. The programme has only had one first year intake of 4 students in 2012/13; since then no new offers have been made. There are currently 5 students in Year 4. This programme, originally validated as a one-year add-on degree in 2010, has so far had a continuous single-digit transfer entry from graduates of the L7. Effectively the ab-initio Honours programme still operates chiefly as an add-on progression route for Level 7 graduates achieving 50% or better, but with current low enrolments in the L7 and L8, the final 'progression stage' may also cease to operate in the near future. Based on initial CAO choices, the programme team does not anticipate a significant turnaround in enrolments in the coming year, so opted not to include the Level 8 in the CAO entry for this year.

While the programme board expressed major concerns about the future of the BIS and BES degrees and had been discussing various options, the Panel found there did not seem to be a definite action plan in place as yet to address this critical situation. The Panel also noted that the staff involved appeared to be extremely busy with teaching and research, and that no allocation of time appeared to have been set aside to actively promote the course.

Options discussed by the programme boards also included a Common Entry stage. CIT currently offers a Common Engineering Honours Entry programme only. Entrants must have achieved a minimum of D3 in

Leaving Certificate Honours Maths (or an A2 in LC Ordinary Maths); a HC3 or better is recommended. Students on the Common Engineering Entry are currently only allowed to progress to Stage 2 of an Engineers Ireland-accredited Honours degree, which however does not include the Energy Engineering programmes as they do not have the HC3 Maths requirement. The BEng (Hons) in SEE is instead accredited by the Energy Institute, the professional body for the energy industry. Progression onto the SEE and BES degrees would be possible for interested students entering through the Common Engineering Entry, but the programme teams cannot advertise this option. This means that the Energy Engineering programmes are not currently able to benefit from the advantages of a Common Entry, such as providing students with exposure to engineering fields that they may not have been familiar with prior to entry.

All stakeholder groups observed that Building Services Engineering in particular did not have a distinct enough profile with potential entrants, parents and guidance counsellors. The Panel heard that present school leavers and guidance counsellors were generally unaware of the great quality and variety of the BIS and BES programmes and of the spectrum of career opportunities open to graduates. Guidance counsellors often sent school leavers down the 'safe' path of mechanical or chemical engineering instead because they thought they knew what those disciplines entailed. Many entrants also still stayed away from any programme with "Building" in the title because they associated this with the construction sector.

With regard to the BEng (Hons) in SEE, the depth and breadth of this programme had also come as a surprise to some learners after entry. Aspects which exceeded expectations were the emphasis on social and policy issues and on improving energy performance of existing systems.

Demand for Graduates (BIS / BES / SEE)

The observations on enrolments contrast strongly with the findings on employer demand for the graduates of the degree programmes, particularly in BIS / BES.

A large number of building services engineering consultants and contractors, including some of Ireland's largest and longest established firms, have offices based in Cork, and require a constant supply of graduates to meet the demands of their industrial partners. Feedback from industry would suggest that the building services and building energy sectors are very buoyant at the moment and that companies are actively recruiting graduates. However the employer representatives stressed that there are currently very few graduates available, and expressed major concerns about the very low numbers of students studying within this field in CIT and in other third-level institutions around Ireland. Current difficulties in recruiting building services engineers are forcing employers to look at graduates from other engineering disciplines, such as mechanical and civil engineering, to fill building services graduate positions, who must then be re-trained using in-house graduate training programmes. Employers are also looking to recruit graduates abroad.

The industry representatives were very concerned about the future viability of the BIS and BES programmes, which had been providing graduates to these companies locally for over 25 years, and expressed an interest in engaging with CIT in an effort to promote, publicise and revitalize the

programmes. The Panel agrees that a large amount of time and effort needs to be set aside to allow the programme board to develop an action plan to promote and advertise the programmes.

The Panel heard that the employment situation for graduates of the BEng (Hons) in Sustainable Energy Systems had also been good. A surprising finding of the graduate destinations surveys was the wide variety of the areas and organisations where graduates had found employment, signalling the broad employability of graduates, but possibly also a somewhat diffuse programme profile. SEE graduates noted that given the opportunity, a good number of Sustainable Energy students might have considered a transfer into the BEng (Hons) in Building Energy Systems, as exposure to building energy-related material in the later stages of SEE made them realise the employment potential of this field.

Retention and Pass Rates (BIS / BES / SEE)

The SEE programme team noted that retention on the programme remained high. Pass rates had dropped somewhat in recent years, coinciding with a drop in average CAO entry points, though the entrants with low points overall were not necessarily the ones failing.

Though the Energy Engineering programmes do not have a HC3 Maths requirement, their technical demands are such that incoming students still need a reasonable mathematical and technical standard to comfortably complete the programmes. The proactive support from the Department of Mathematics and Academic Learning Centre in developing students' mathematical and technical proficiency was acknowledged.

Retention was also flagged as a potential viability issue requiring attention in some of the external examiner's reports for BIS/BES.

Relevance of Programme Content (BIS / BES / SEE)

In the Panel's view, there is clear evidence from the documentation and discussions that the programmes deliver material that is up to date and relevant to the employers' needs. In general the feedback received indicated that the students are happy with the course content that is being delivered, the graduates feel they are well equipped to find suitable employment, and the employers are happy that the graduates have the required skills set to be of benefit to their organization.

There was also good evidence that the programme team of the BEng (Hons) in Sustainable Energy Engineering has been continually gathering both formal and informal feedback from students, graduates and employers in relation to the programme content from the outset.

Special Purpose Award (Certificate in Plant and Piping Design) – Demand and Relevance

Enrolments for the Certificate in Plant and Piping Design, an 18-month part-time SPA conceived as a 'Springboard' offering, have not been an issue, with 15 entrants in 2013/14 and 19 in 2014/15.

Based on the documentation and discussions, the Panel concluded that the Certificate is meeting the needs of industry and allow re-training of personnel suitable for employment by consultants and contractors providing services to the regions industrial and pharmaceutical industry.

Commendations, Recommendations and Requirements:

3. Based on the above considerations, the panel **recommends** that the department and the programme board engage strongly with Cork-based engineering consultants, contractors and schools/guidance counsellors in an effort to actively promote the programmes and make them more attractive to school leavers. The Panel also **recommends** that the department should work towards securing an adequate time allocation for course promotion as soon as possible.
4. The Panel supports the view that a title change for the BIS/BES degrees may be helpful in recruiting entrants into a suite of programmes for whose graduates there is clearly good demand from industry. The Panel therefore **strongly recommends** that the current programme title of the **BEng in Building Services Engineering** in particular should be reviewed. Specifically it is felt that the word “Building” in the title may at this point be discouraging many applicants. As the programme focus is mainly mechanical building services, a suggestion would be to include the word “Mechanical” in the title. The Panel agrees with the programme team that any proposed revised title would need to remain representative of the programme profile.
5. The Panel further **recommends** that the Engineering Schools should give serious consideration to options for linking the Energy Engineering programmes into a Common Engineering Entry as a means of supporting programme viability. While Engineers Ireland accreditation of a target programme is desirable, this does not need to limit the opportunities for progression of students from a Common Entry stage, particularly where accreditation has been or can be gained from other well-respected professional bodies.

3. Programme Outcomes and Overall Programme Structure

Findings and Observations

Embedded HC in Engineering in Building Services Engineering

The Level 7 degree in Building Services Engineering has an option for students to draw on an embedded Higher Certificate as an exit award after Year 2. However, the Programme Outcomes for the HC and a statement outlining the benefit of this award to exiting students were not submitted to the Panel.

M&S Programme Structure Issues

It was noted that **Semester 5** of the proposed **BEng (Hons) in Building Energy Systems** exceeds the maximum allowable number of four final exams. Given current uncertainty over the viability and future direction of the programme, the Panel felt that a potentially major restructuring of Semester 5 of BES to avoid this was not called for at this point.

The Panel also noted that **Semester 5** of the proposed **BEng (Hons) in Sustainable Energy Engineering** did not include any elective choice. This resulted from constraints in the sequencing of the material produced by introduction of a large work placement module in Semester 6 and had been approved through the Programme Change Process a few years ago.

Free Choice

All students and graduates interviewed expressed concerns about the Free Choice elective. Issues raised included uncertainty over available module choices and appropriate module levels, difficulty in obtaining contact information in relation to any particular module, lack of guidance in relation to elective module selection overall, and timetabling.

Students and graduates present noted that as a result of their uncertainties around Free Choice, they had all ended up taking the single elective module offered within the programme instead of a Free Choice module, which in effect meant there were no electives.

While the schedules for BIS/BES still include only one cognate elective per semester, the Panel notes that the proposed schedules for SEE have been improved with regard to elective choice and now include two cognate electives in Semester 2 and four in Semester 7. However, based on the discussions it appears to the Panel that there is currently no administration of Free Choice modules.

BEng in Building Services Engineering – Work Placement

On discussion of the issue with the programme team, the Panel considers that the Level 7 programme in Building Services Engineering would definitely benefit from having a work placement component. This would differentiate the programme and increase its attractiveness for potential applicants.

While the Panel acknowledges the difficulty in fitting a work placement component into a 3-year programme, a somewhat 'creative' approach to semester schedule design might help free up the requisite time. If, for instance, two Free Choice modules were moved into either semester 4 or 6, the timetable could be arranged to allow students to go on placement one or two days each week.

External Examination

Finally, the Panel notes the observation of one external examiner that he was only reviewing certain module streams within the programme, but was asked to complete a report commenting on the overall performance of the programme.

Commendations, Recommendations and Requirements:

6. The Panel would like to **commend** the programme boards on the proposed changes to module content and sequence of delivery. The panel feels these changes are well-considered overall, will enhance the programmes, and will provide a more rounded graduate meeting industry needs.

7. In particular the move to start Maths in Semester 1 instead of Semester 2 should be of benefit to the students, and is **commended**. The panel supports the view of the CIT Mathematics Department and the programme board that, in order to successfully and effectively teach maths to engineering students, class sizes must be kept small. Ideally, students from different programmes should be kept separate for maths lectures and tutorials where possible.
8. There is clear evidence from the discussions and deliberations that took place with each of the stakeholder groups that each of the programmes reviewed is meeting the programme learning outcomes as set out in the programme documentation. The linkage between the module learning outcomes and the Programme Outcomes is also clearly shown. The Panel **commends** this.
9. The Panel **requires** that a set of Programme Outcomes and a brief statement of industry need for the **HC in Building Service Engineering** are drawn up and submitted to the Registrar's Office for review as a condition for revalidation of this embedded award.
10. The Panel **requires** the department to reapply to Academic Council for a renewal of derogation from the Free Choice requirement in Sem. 5 of the **BEng (Hons) in Sustainable Energy Engineering**.
11. The Panel **recommends** that the programme board for the **BEng in Building Services Engineering (L7)** should explore options for adding work placement to the Level 7 degree.
12. The Panel **recommends** that the programme team for the **BEng (Hons) in Building Energy Systems** should pay close attention to any potential issues arising for students from the high number of final exams in Sem. 5 of the programme. Should the intake rise to ensure a sufficiently sustainable throughput for Sem. 5, the structure of this semester will need to be revisited, with a view to reducing the number of final exams to no more than four.
13. As a minimum measure to support Free Choice, the Panel **recommends** that a "Free Choice Coordinator" be appointed for each programme to offer advice to the students and ideally to support the department in achieving enhanced Free Choice options. The Panel would also encourage the Institute to investigate system-wide measures to improve the administration of Free Choice and the availability of Free Choice modules.
14. The Panel acknowledges that the organisation of external examination cannot be addressed at the departmental level, but **recommends** that the perceived mismatch between the limited number of modules reviewed and the requirement to comment on the totality of the programme performance should be brought to the attention of the Institute.

4. Subject Streams and Modules

Findings and Observations

BEng (Hons) in SEE – Coverage of Policy and Legislation

The 2011 external examiner's report for SEE highlighted the fact that the legislative aspects of sustainable energy engineering required strengthening. The Panel agrees with this assessment, but found no evidence that this has been specifically addressed in the programme now proposed.

Employer Observations on BIS / BES Programmes

Employer representatives identified any deficiencies of BIS/BES work placement students and graduates they had encountered as being in the areas of cost control, project management, motivation of self and others, and the understanding of psychrometric processes.

Employers noted that students had a good understanding of the basic calculation procedures for building services design but lacked an overall appreciation of the full project process (inception to completion).

Commendations, Recommendations and Requirements:

15. **BIS/BES** students felt that the number of modules offered in relation to BIM, i.e. Revit and Navisworks, could be expanded. This had previously also been highlighted by an external examiner. A review of the proposed module changes shows that the BIM content has been updated and that the issue has consequently been addressed. The Panel **commends** the programme board on this, and **suggests** that the board might consider the possibility of dropping one further CAD module in favour of a third REVIT module.
16. The Panel **recommends** that a module covering policy and legislation relevant to the energy industry be introduced into the **BEng (Hons) in Sustainable Energy Engineering**.
17. In the context of the discussions on elective choice, stakeholders in particular commented on the absence of European language provision as a gap in the programmes. The Panel **recommends** that the department investigate the inclusion of a European language stream as an elective option throughout the semesters of the Energy Engineering programmes.
18. The Panel **recommends** that coverage of energy simulation software packages in the appropriate modules should be extended to include more packages if there is opportunity.
19. Finally, the Panel **recommends** that the BIS / BES programme board should take on board as appropriate the observations referred from employers on skills gaps in work placement students and graduates when next updating the programmes.

5. Implementation of Requirements

2. Completion of Module Moderation Process

Registrar's Office Commentary:

Complete. Registrar's Office Sign-Off:

9. The Panel **requires** the department to reapply to Academic Council for a renewal of derogation from the Free Choice requirement in Sem. 5 of the **BEng (Hons) in Sustainable Energy Engineering**.

Registrar's Office Commentary:

A request for a renewal of derogation from the Free Choice requirement in Sem. 5 of the BEng (Hons) in SEE was received by Registrar's Office from the Head of Department of PET Engineering on 11 June 2015 as follows:

"RE: Application for renewal of derogation from the Free Choice requirement in Semester 5 of the B.Eng. (Hons) in Sustainable Energy Engineering.

The course board would like to make the above request for a renewal of derogation from the Free Choice requirement in Semester 5. The reason for the request is based on the need to ensure that core programme material is covered across all the subject streams, whilst accommodating the 15 credit work placement module in Semester 6.

The students are, however, able to select their own work placement location across a wide variety of industry sectors, and consequently they are able to select their own final year project theme as well. This enables them to tailor their overall learning experience at the final stage of the programme into a sector that they have developed an interest in.

Whilst this is not the same as being able to select a Free Choice module it does allow some amount of self-direction, and, if they choose to use the opportunity to undertake an Erasmus exchange, or work with an overseas company for the work placement, they can develop their foreign language skills as well.

The Free Choice is available in semesters 2, 3 and 7, and in each instance we have ensured that there is more than one cognate elective available for them to select from."

Derogation had originally been granted on comparable grounds on introduction of a large work placement module into Semester 6, see. Section 3, *M&S Programme Structure Issues* above.

Registrar's Office therefore ***recommends to Academic Council*** to consider and, as appropriate, approve the request for renewal of derogation.

Complete. Registrar's Office Sign-Off: 11 June 2015.

10. The Panel ***requires*** that a set of Programme Outcomes and a brief statement of industry need for the **HC in Building Service Engineering** are drawn up and submitted to the Registrar's Office for review as a condition for revalidation of this embedded award.

Registrar's Office Commentary:

A Programme Descriptor for the HC in Engineering in BIS (NFQ L6) including Programme Outcomes and Semester Schedules has been set up in the Akari Document database. In addition, a short supplementary programme document was received from the Head of Department of PET Engineering on 11 June setting out the educational aim, employment path, course delivery philosophy and achievement of Programme Outcomes for the embedded HC (see Appendix).

Registrar's Office has reviewed the Programme Outcomes and supplementary programme document for the embedded award and considers these appropriate to the level and graduate profile of the programme. The indication of need is also deemed appropriate.

Complete. Registrar's Office Sign-Off: 11 June 2015.

**APPENDIX: PROGRAMME DOCUMENT FOR HC IN ENGINEERING IN BUILDING SERVICES ENG.
(embedded exit award of the BEng in Building Service Engineering)**

DEPARTMENT OF PROCESS ENERGY & TRANSPORT ENGINEERING

Higher Certificate in Building Services Engineering

Programmatic Review 2015

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1 Educational Aim of Programme

Graduates of this course will have the ability to undertake supervised design of basic building services systems and to produce services design drawings to a high technical standard. They will possess the knowledge, skills and competences to function as an engineering technician.

The Higher Certificate in Building Services Engineering is a fusion of mechanical and electrical engineering to service a niche employment market in the design and selection of operating systems to maintain internal environments in buildings and the design and selection of facilities in the indigenous industrial sector.

In order to facilitate the design and selection of building services and industrial services a student will be required to draw from a range of knowledge bases:

Quantitative knowledge of a variety of building services systems and industrial systems.

Theoretical knowledge of the fundamental mechanical and electrical principles for the **qualitative** design of simple Building Services systems such as heating, ventilation, piping, cabling and power systems.

Practical knowledge in the production of working drawings, technical reports and coordination of interdisciplinary project work.

On successful completion of this programme, a graduate will be able to:

Function autonomously or as a member of a group in the production of industry standard working drawings which are unique to each project.

Plan and schedule the production of such drawings.

Apply mechanical and electrical theoretical principles to the design of building and industrial services based on operating parameters supplied by clients.

2 Employment path

The Building Services programme has been designed to effectively produce graduates who fit two career paths:

- A graduate who is readily employable.
These graduates must have the ability to undertake supervised production of services design drawings to a very high technical standard and to function as a junior design engineer or junior site engineer.
- A graduate who can pursue an ordinary degree programme.
These students must possess the mathematical ability and the technical design ability to progress in further studies and must also have the capacity for self-directed learning. Our graduates must possess the knowledge, skills and competences to function as engineers. They must have a balance between the hard skills (design ability, technical ability) and the

soft skills (communications, team work, management). The programme outcomes reflect the above requirements.

On successful completion of this programme, a graduate will be able to:

Work as a **CAD technician** taking full responsibility for the quality of the finished working drawing.

Work as a **Junior Engineer** as part of a multi-disciplinary design team, under the guidance and supervision of a senior engineer.

Work as a **Junior Site Engineer** taking a key role in planning, allocation of resources, interpretation of design drawings, production of working drawings and some supervision of installed services.

3 Course Delivery Philosophy

The students entering this course do so with basic levels of mathematics, science and engineering level subjects. The basic philosophy adopted in the 1st Year of the course is to improve their mathematics skills and to introduce them to the different engineering disciplines and technologies for building services engineering e.g. mechanics, heat and fluids, electrotechnology. This will enable the student to undertake basic calculations e.g. heat flow on an individual element. Modules on mechanical and electrical CAD and drafting are also provided along with basic communication skills and the role of the engineer in society. The typical learning outcomes tend to be of the following type: *identify materials process services etc, sketch, describe, explain the relevance of, select* and so on.

2nd Year builds on key modules such as mechanical technology, electro-technology, mechanical and electrical CAD, continuing to develop at a much deeper level with a significant design emphasis and introduction of higher levels of mathematics and introductory statistics. The learning outcomes for the different modules change from *describe, list, explain* to *calculate, design, size, perform calculations* across all of the disciplines at a predominantly component rather than system level. The student must complete a major Project incorporating the mechanical engineering design aspects of a major item of Building and/or Industrial Services into an overall comprehensive design application of Building/Industrial Services.

4 Achievement of Programme Outcomes

4.1 Programme Outcome (1): Knowledge - Breadth

The graduate of this programme will demonstrate the ability to apply knowledge from a wide technical base encompassing mathematics, science, ICT, design, management and engineering practice in the solution of well-defined engineering technology problems.

In the 1st year on the course, the student is introduced to the basics of engineering theory and building services equipment. The student learns relevant theory covering mathematics, mechanics, thermodynamics, fluids, pipe work fabrication, electrical principles, building services plant, drawing, information technology and Health and Safety.

The learner focus is on gaining a fundamental knowledge and understanding of a wide variety of basic engineering topics. This breadth of knowledge provides the foundation technical skills required to contribute to the design of a wide range of engineering systems.

As the student progresses to 2nd Year specific knowledge of relevant engineering theory is increased. Course content focuses more on giving the student an understanding of well-established principles, specific theory and relevant technology. The student's depth of knowledge is increased allowing the student to understand the engineering theory to be used to meet specific design needs.

4.2 Programme Outcome (2): Knowledge - Kind

The graduate of this programme will demonstrate the ability to apply understanding of the fundamental concepts to the solution of well-defined engineering technology problems.

Well defined Building Services technology problems typically encompass heat loss and heat gain calculations, pipework sizing, boiler and pump sizing, ductwork sizing fan sizing, cabling sizing etc. Such problems involve the integration of mathematical techniques, fluid dynamics, thermodynamics, electrical principles, equipment operational characteristics and industry norms. Whilst individual modules test specific well defined modules, the project in second year requires the student to draw extensively from a significant range of their knowledge base to solve a series of inter-connected well-defined problems which lead to a full system design.

4.3 Programme Outcome (3): Skill - Range

The graduate of this programme will demonstrate the ability to use basic techniques, skills and modern computer-based engineering tools to contribute to the solution of building services technology problems.

Effective communication for Building Services engineers takes many forms:

- Communication of their design intent through drawings
- Structured calculations which withstand rigorous audit by others
- Oral presentation of their work
- Effective report writing

Building Services engineers convey their design intent through schematics and general arrangement drawings for HVAC services. There are 4 dedicated mechanical and electrical CAD modules within the first two years of the course specifically designed give students the requisite skillset in CAD draughting.

Structured calculation procedures are emphasised in all mathematical based modules.

4.4 Programme Outcome (4): Skill - Selectivity

The graduate of this programme will demonstrate the ability to apply industry standard design techniques, codes of practice and regulations in the design of a system/ component/process to meet specified needs and to contribute to the assessment of the technical performance of the a system/component/process mechanical system.

Design to meet specified needs and assessment of technical performance of systems can really only take place when the fundamentals of component design have been covered and when a sufficient depth of knowledge of systems operation has been gained. Typically this will be towards the end of second year. The design project encapsulates complete systems design to achieve a specific need such as offsetting heat loss or providing adequate ventilation. Systems must be designed to ensure acceptable equipment performance (proper design of ducting and piping systems to ensure reasonably sized fans and pumps) and compliance with legislation (Technical Guidance Documents).

4.5 Programme Outcome (5): Competence - Context

The graduate of this programme will demonstrate the ability to recognise and contribute to the solution of common engineering technology problems in Building Services engineering.

The ability to select and apply solutions from a knowledge of engineering discipline-specific technologies is horizontally integrated within each year. Basic skills across a number of disciplines and sciences are acquired in 1st Year and these are enhanced and applied to different levels of sophistication in 2nd year.

4.6 Programme Outcome (6): Competence - Role

The graduate of this programme will demonstrate the ability to work autonomously and as a member of a multidisciplinary team.

Over the two years of the course, opportunities are provided for the student to undertake work in a range of situations; individual tasks, which foster the spirit of independent endeavour; team projects where interpersonal skills may be developed and aspects of collaboration and conflict resolution explored; and tasks which require the student to consider a problem from the standpoint of another professional (architect or civil engineer). Other elements studied during the course seek to establish patterns of learning and problem solving that will be carried forward into professional life, empowering the graduate with the resourcefulness and confidence to continue to study, develop and learn throughout their career and beyond.

From 1st Year, *individual skills* are developed over a wide range of course elements ranging from managing individual project work, preparing communication assignments, and completing a suite of CAD assignments.

Team working skills are essential for the successful completion of the group tasks which are primarily undertaken in the 2nd year of the course, increasing in complexity and with a reduction in direct supervisor involvement as the course progresses. The principles of team working are explained to the students as part of the management course, and these principles can then be put into practise in the Projects.

4.7 Programme Outcome (7): Competence - Learning to Learn

The graduate of this programme will demonstrate the ability to identify and address learning needs within a structured learning environment and an awareness of the need for continued professional development.

1st and 2nd year subjects give the students a firm grounding in Building Services technology and design principles. However in a lot of cases the derivation of formulae from 1st principles is not applied. Emphasis is on the application of formulae with special attention to assumptions used and industry norms. Students are constantly reminded of this limitation to their knowledge base.

Lifelong Learning and the ability and confidence to continue to develop new skills and competences is engendered in the student by providing a number of elements in the learning programme which require considerable self-direction. The use of CAD, the Project work, the Research Project, use of professional modelling software and the extensive range of communication skills required to complete elements of the course require the student to have successfully developed the abilities to learn beyond the direct instruction of the lecturing staff, and to be able to manage, direct and to some extent assess their own progress in a topic.

4.8 Programme Outcome (8): Competence - Insight

The graduate of this programme will demonstrate an understanding of the responsibility of the engineering profession to society and the need for high ethical standards in all aspects of engineering practice.

Whilst the *need* for high ethical standards is stressed in the context of the role and the position of trust and esteem enjoyed by the professional engineer in society, the emphasis in CIT has also been to foster a *culture* of ethics within and between the staff and student bodies. This leads to the mutual trust without which the pedagogical encounter between staff and students would be impossible.

From 1st Year, the underlying principles of respect for the person, the process and the environment are imbued. Justice and fairness are transparent in assessment of student effort; feedback to students; and the sharing of responsibility and decision-making. From the start, students are made aware that they are responsible for any work submitted in their own name; that they must carry their weight in shared exercises viz. laboratories, group projects, shared tasks. Students are made aware of the meaning and consequences of plagiarism in any form.

Moving to 2nd Year, more formal aspects of the duties and responsibilities of the professional engineer are stressed: Health & Safety Regulations; Codes of Practice; Professional Membership are introduced.