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Accreditation Based on Output Standards – An IEE Perspective

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Overview

- Background to UK-SPEC
  - Generic Learning Outcomes
  - Discipline-Specific Learning Outcomes
- Implications for Accreditation
  - Changes to the accreditation process
  - Competence threshold
- Conclusions

UK-SPEC

- EC^{UK} launched the UK Standard for Professional Engineering Competence (UK-SPEC) in December 2003
  - Competence & Commitment
  - Distinctive roles for Chartered Engineers, Incorporated Engineers & Engineering Technicians
  - More flexible approach to achieving CEng status; MEng provides ‘fast track’ route
  - Emphasis shifted from entry standards to output standards

Accreditation & Output Standards

- Institutions must be able to demonstrate that graduates from their programmes have achieved specific learning outcomes
- UK-SPEC has laid down generic learning outcomes that apply to all engineering programmes
- The IEE, along with other professional bodies, is interpreting these learning outcomes to make them discipline-specific

UK-SPEC Learning Outcomes

- General Learning Outcomes
  - Knowledge and Understanding
  - Intellectual Abilities
  - Practical Skills
  - General Transferable Skills

UK-SPEC Learning Outcomes

- Specific Learning Outcomes
  - Underpinning Science & Mathematics
  - Engineering Analysis
  - Design
  - Economic, Social & Environmental Context
  - Engineering Practice

Key Issues

- Range of degrees accredited by IEE is very broad – learning outcomes will vary according to the nature of the subjects studied
- Identified the need to strike a balance between over-prescription (which inhibits diversity) and lack of definition (which inhibits objective decision making)

IEE Approach

- Range of degrees divided into 8 subject groups or themes
- Using the UK-SPEC engineering-specific learning outcomes as a template, identify the core outcomes that graduates should be expected to achieve.
- Where necessary the learning outcomes are differentiated according to the various subject groups

IEE Subject Themes

Group	Subject Theme
A	Electrical Engineering
B	Electronic Eng (Analogue/Digital)
C	Control and Instrumentation Eng
D	Communication Engineering
E	Manufacturing Systems Engineering
F	Digital Systems Engineering
G	Computer Systems Engineering
H	Software Eng/Computer Science

Joint Degrees

- A need was identified for a ninth group (Group I) to account for those subjects that can be combined with Electrical & Electronic Engineering and related disciplines (examples include Music Technology, Biophysics, Business Studies etc.)
- The Learning Outcomes that follow have been developed for graduates from BEng (Hons) degree programmes. The work is currently being extended to include MEng programmes and routes to IEng.

UK-SPEC Learning Outcomes - Underpinning Science & Mathematics

Students must be able to demonstrate:

1.1 Knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, to enable appreciation of its scientific and engineering context, and to support their understanding of historical, current, and future developments and technologies;

IEE Learning Outcomes – All Groups

Discipline-Specific Learning Outcomes

Students must be able to demonstrate competencies in:

Group	Learning Outcomes
A - G	AC Electric Circuits, Basic Electrical and Magnetic principles, Basic Optics, Basic Properties of Materials, Basic Quantum Physics, Basic Thermodynamics and Fluid Mechanics, Circular Motion, DC Electric Circuits, Forces, Energy and Work, Newton's Laws of Motion, Vibrations and Waves.
H	No specific competencies are required

UK-SPEC Learning Outcomes - Underpinning Science & Mathematics

Students must be able to demonstrate:

1.2 Knowledge and understanding of mathematical principles necessary to underpin their education in their engineering discipline and to enable them to apply mathematical methods, tools and notations proficiently in the analysis and solution of engineering problems;

IEE Learning Outcomes – Group B

Discipline-Specific Learning Outcomes

Students must be able to demonstrate competencies in:

Group	Learning Outcomes
B	Mental Approximation, Algebraic Manipulation, Simultaneous Equations, Quadratic Equations, Complex Numbers, Trigonometry, Differential & Integral Calculus, Line, Area & Volume integrals, Vector Algebra, Taylor & Maclaurin Series, Exponential, Hyperbolic & Inverse Functions, Probability & Statistical Analysis, Fourier Analysis, Laplace Transforms, Convolution, Matrix Methods, Ordinary Differential Equations, Partial Differential Equations, Dimensional Analysis.

UK-SPEC Learning Outcomes - Engineering Analysis

Students must be able to demonstrate:

2.1 Understanding of engineering principles and the ability to apply them to analyse key engineering processes;

IEE Learning Outcomes – Group B

Students must be able to:

Group	Learning Outcomes
B	Apply physical principles and quantitative methods to the development of abstract models for electronic components including passive components (e.g. resistors, capacitors and inductors) and semiconductor devices (e.g. diodes, bipolar junction transistors, field effect transistors and operational amplifiers). Demonstrate an understanding of the trade off between the complexity of the model and its ability to predict device behaviour accurately. Demonstrate a knowledge and understanding of the range of applicability of abstract models of electronic components and their fundamental limitations in linear and non-linear circuit applications.

UK-SPEC Learning Outcomes - Engineering Analysis

Students must be able to demonstrate:

2.2 Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques;

IEE Learning Outcomes – Group B

Students must be able to:

Group	Learning Outcomes
B	Apply analytical methods (i.e. circuit theory) and modelling techniques (i.e. electronic device models) to the identification, classification and description of electronic circuits and their performance in response to a range of externally applied stimuli. The range of circuits should include: - Amplifiers - Signal Generators and Waveshaping Circuits - Power Supplies and Voltage Reference Circuits - Mixed Analogue-Digital Circuits - Optoelectronic Devices and Circuits

UK-SPEC Learning Outcomes - Engineering Analysis

Students must be able to demonstrate:

2.3 Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems;

IEE Learning Outcomes – Group B

Students must be able to:

Group	Learning Outcomes
B	Use quantitative methods and appropriate computer software tools to solve engineering problems involving the analysis of electronic circuits. The types of analysis will generally include the following: - DC operating point and transfer characteristic - AC transfer characteristic - Transient analysis (time domain) - Spectral analysis (frequency domain) - Noise analysis - Sensitivity analysis (optimisation)

UK-SPEC Learning Outcomes - Engineering Analysis

Students must be able to demonstrate:

2.4 Understanding of and ability to apply a systems approach to engineering problems.

IEE Learning Outcomes – Group B

Students must be able to:

Group	Learning Outcomes
B	Demonstrate a knowledge and understanding of system-on-chip design methodologies and apply them to the top-down design of electronic systems.

Accreditation Process

- IEE Accreditation should be timed to coincide with institutional internal review processes (e.g. Periodic Review)
- As far as possible, a common set of documentation should be used
- Self-evaluation document (SED) to include commentary showing how programme outcomes map onto the IEE Learning Outcomes

Evidence of Outcomes

- Accreditors will require access to samples of student work – examination scripts, coursework and projects
- Further evidence can be provided by results histograms showing the distribution of examination and coursework marks

Competence Threshold

- What is the minimum level of achievement that corresponds to the UK-SPEC competence requirements for CEng registration?
- One view is that on average across the UK the minimum level of competence should be considered as equivalent to a 2.II BEng/MEng (Hons) degree
- In some cases it may be appropriate to specify a higher or lower class of degree

Conclusions

- The IEE has developed a set of output standards for use in the accreditation of degree programmes
- The accreditation process will need to be modified to take account of these developments
- Accreditation should be aligned with institutional periodic review processes
- A competence threshold will need to be determined. Should it be 2.II? Variable?