Solihull College & University Centre | Stratford-upon-Avon College

Programme Specification

HNC Manufacturing Engineering

Awarded by

Solihull College & University Centre

Stratford-upon-Avon College

Title of Programme: HNC Manufacturing Engineering

This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided.

1.	**Awarding Body**	Pearson BTEC
2.	**Teaching location**	Woodlands Campus, Solihull College
3.	**Accreditation details**	N/A
4.	**Final award**	Higher National Certificate
5.	**Name of award**	Pearson BTEC Level 4 Higher National Certificate in Engineering (Manufacturing Engineering)
6.	**Codes**	
	a. UCAS code	N/A
	b. Solihull Qualification Code	ENFDA41
	c. Edexcel Programme Code (& approval dates)	603/0450/9 24th April 2018
7.	**QAA Subject Benchmark or other external reference such as published by Edexcel if the course is a Higher National**	Engineering 2015 Subject Benchmark http://www.qaa.ac.uk/en/Publications/Documents/SBS-engineering-15.pdf
8.	**Date this specification applies from**	01.09.2018

Approved	Mick Nicholl Head of School – Engineering

9. Educational Aims of the Programme

This programme aims to:

- Equip individuals with knowledge, understanding and skills for success in employment in the Manufacturing engineering and related sectors.
- Enable progression to an undergraduate degree or further professional qualification in Manufacturing engineering or related areas.
- Provide opportunities for specialist study relevant to individual vocations and contexts.
- Develop the individual's ability to make an immediate contribution to employment in the Manufacturing engineering sector, through effective use and combination of the knowledge and skills gained in different parts of the programme.
- Develop a range of skills and techniques, personal qualities and attributes essential for successful performance in working life and thereby enabling learners to make an immediate contribution to employment.
- Provide education and training for a range of careers in the Manufacturing Engineering sector.
- Provide opportunities for learners to gain a nationally-recognised vocationally-specific qualification to enter employment in the sector or progress to higher education qualifications such as a fulltime degree in a related area.
- Present opportunities for learners to focus on the development of the higher-level skills in Manufacturing engineering and related areas.
- Provide opportunities for learners to develop a range of skills and techniques and attributes essential for successful performance in working life.
- Assist in the development of learners' knowledge, understanding and skills in the field of Manufacturing Engineering.

10. Intended Learning Outcomes

The programme provides opportunities for students to develop and demonstrate knowledge and understanding, skills, qualities and other attributes in the following areas:

Subject knowledge and critical understanding includes:

A sound basic knowledge and understanding that includes:

- Engineering Mathematics methods relevant to Manufacturing Engineering.
- Engineering practice (including codes of practice, regulatory frameworks and requirements for safe operation).
- Scientific principles underpinning the specific engineering discipline such as energy transfer systems i.e. heat transfer through lagged pipe work system and power transmission in machinery
- Application of computers for quantitative analysis, simulation and solution of engineering problems and the manipulation and presentation of engineering information, such as the use of PLC, Robots, CAD and CAM CNC software.
- General principles and techniques of design and the characteristics of basic engineering materials and components
- Management and business practices

Higher level academic/ intellectual skills including ability to:

- Plan, conduct and report a programme of research
- Analyse and solve engineering problems
- Design a system, component or process to meet a need
- Be creative in the solution of problems and in the development of designs
- Evaluate design, processes and products, and make improvements.
- Integrate and evaluate information and data from a variety of sources.
- Use of commercial software to solve engineering problems

Higher practical and professional skills including the ability to:

- Plan and execute safely a series of experiments.
- Use laboratory equipment and software packages to generate data
- Design a system, component or process to meet a need.
- Be creative in the solution of problems and in the development of designs.
- Evaluate design processes and products and make improvements
- Integrate and evaluate information and data from a variety of sources.
- Produce a design for a system, component or process to meet specified requirements relating to engineering Management
- Research and undertake tests for a design solution and report the results effectively, within a Project
- Cognitive skills of critical thinking, analysis and synthesis

- Effective problem solving and decision making using appropriate quantitative and qualitative skills including identifying, formulating and solving problems
- Effective communication skills, both oral and written, using a range of media widely used in the sector, e.g. the preparation and presentation of reports
- Numeric and quantitative skills including data analysis, interpretation and extrapolation
- Effective use of communication and information technology for Manufacturing related areas.
- Effective self-management in terms of time, planning and behaviour motivation, self-starting and individual initiative.
- Developing an appropriate learning style.
- Effective performance within a team environment including leadership, team building, influencing and project management skills
- Interpersonal skills, e.g. effective listening, negotiating, persuading and presentation

Higher Level transferable skills development including:

- The ability to manage and develop self
- The ability to communicate ideas effectively both orally and in writing
- The ability to apply numeracy in an Manufacturing engineering context
- The ability to apply technology in an Manufacturing engineering context
- To manage tasks and solve problems
- Apply design and creativity to solving and array of aerospace engineering problems
- The ability to work effectively as an individual and as part of a team
- The ability to be flexible and respond to the change within the Manufacturing engineering sector
- Designing, planning, conducting and reporting on the needs of the Manufacturing engineering sector.
- The ability to use ICT and Management Information Systems in an Manufacturing engineering setting.
- Read and use appropriate literature with a full and critical understanding
- Solve problems applying subject knowledge and understanding to address familiar and unfamiliar problems within a Manufacturing engineering context.
- Think scientifically, statistically and logically in relevant contexts.
- Think independently and take responsibility for their own learning whilst recognising their learning style

Teaching and Learning Methods

The following opportunities are provided to enable learners to develop and demonstrate their achievement of learning outcomes:

- Acquisition of core knowledge is through a mixture of lecture/presentations/demonstrations, tutorials, group seminars and directed study
- Analytic thinking skills are developed through discussion and debate in-group and tutorial sessions and question sheets.
- Practical skills are an essential component of the programme and will involve group work, presentations, demonstrations, laboratory experiments,
- Common skills such as oral and written communication are developed by means of course notes, presentations of project work, appropriate reading, and written tutor feedback.
- Design skills and the ability to create simple engineering designs using multi-disciplinary approach is developed by means of sample project work.

Assessment methods

Summative assessment methods include:

- Written work required in various formats such as reports, essays, blogs, dissertation
- Oral presentations to a group audience using teaching aids such as PowerPoint, poster, Electronic Whiteboard, Practical Models.
- Assessment is enhanced by encouraging the students to use technology e.g. digital cameras, flip videos, analysis software to augment their presentational work.
- Project work.
- Small scale research studies
- Work-based learning

As far as possible all assignment work is connected to a vocational relevant scenario. Students receive individual written and oral feedback within 3 weeks of submission date.

Formative assessment for learning and feedback includes:

- Interactive lectures and question & answer sessions can be used to examine student understanding and identify any additional guidance required.
- Group activities involve students actively contributing to, leading and participating in discussions and debates on a wide range of subject areas, undertaking games or group activities allowing immediate assessment and feedback.
- Subject related tutorials are led by the subject tutor and aim to address a particular module or assignment. These tutorials can be linked to workshop sessions where necessary.
- Workshops are for students to develop skills in self-directed study with the support of tutors. These sessions will be supported by staff but not staff led. There will also be self-directed time for students to further develop these skills and spend time reading around topics using a variety of recommended sources.

- Extension activities/quizzes/Discussion forums on Moodle.
- Presentations are used to support research skills, organisation, time-management skill and are also a confidence-building tool.
- The need for IT support in general will be identified and where necessary, IT support will be organised.
- Diagnostic testing identifying Maths and English support where necessary.

Note:
For further details on assessments, grading criteria, submissions and resubmissions of assignments, please refer to the BTEC Centre Guide to Enhanced Quality Assurance and Assessment by clicking **online.**

Mode of Study
The Higher National Certificate (HNC) is a Level 4 qualification made up of 120 credits. It is usually studied full-time over one year, or part-time over two years. Students can study for the Pearson BTEC Higher Nationals, either as a part time or full-time.

A full-time mode of study requires students to attend college two days per week to study all eight units (or approved units) with the intention to complete the programme in a single year.

A part-time mode of study requires students to attend college one day per week with the intention to complete a maximum of four units in a single year. In some cases, a part-time student may choose the minimum number of unit/s to study in a single year; this may extend the length of part-time study in order to successfully achieve the award.

11. Programme Structure

Module code	Module title	CATS Credit value	Level	Year	Option or Mandatory
Unit 1	Engineering Design	15	4	1	Mandatory
Unit 2	Engineering Maths	15	4	1	Mandatory
Unit 3	Engineering Science	15	4	1	Mandatory
Unit 4	Managing a Professional Engineering Project (Pearson- set)	15	4	2	Mandatory
Unit 7	Machining and Processing of Engineering Materials	15	4	2	Option **
Unit 12	Engineering Management	15	4	2	Option **
Unit 14	Production Engineering for Manufacture	15	4	1	(Specialist unit) Mandatory*
Unit 15	Automation, Robotics and Programmable Logic Controllers	15	4	2	Option**
Unit 17	Quality and Process Improvement	15	4	2	(Specialist unit) Mandatory*
Unit 22	Electronic Circuits and Devices	15	4	2	Option**
Unit 23:	Computer Aided Design and Manufacture (CAD/CAM)	15	4	2	(Specialist unit) Mandatory opt*

Note:

- Optional modules represent choices available to current students.
- * Student to complete specialist units including specialist unit mandatory option*
- **student to choose one unit from the two

Progression to Year 2

Progression onto the second year of the programme requires completion and achievement of a minimum grade of a pass of all first - year units and after a successful progression interview.

Cases of student/s with approved mitigating circumstance who have outstanding referred assessment/s or unachieved assessment/s would be considered on individual bases by the academic exam board and then a decision would be made whether the student would be recommended to achieve the outstanding and/or unachieved assessment/s during the summer break in order to progress onto the second year.

Alternatively, the academic exam board may recommend the withdrawal of student/s with outstanding assessment and/or unachieved assessment decision from the programme.

Each case of a student with outstanding assessment/s or unachieved assessment/s would be considered on individual basis where student/s would be required to complete any outstanding/ unachieved assessment at a minimum pass grade in order to progress onto the second year.

After successful completion of all first-year modules, student/s may choose to transfer from Mechanical Engineering pathway to other different level 4 pathways (including Mechanical, and /or General Engineering, Aircraft Maintenance Engineering and other pathways). The transfer is done after successful interview.

Completion of the Award

For the Manufacturing Engineering pathway, students take the four mandatory core units, two specialist units and an additional two optional units.

In year 2, learners have a choice of selecting one unit from pool A to add to mandatory units.

Pool A – Unit 7: Machining and Processing of Engineering Materials or Unit15: Automation, Robotics and Programmable Logic Controllers or Unit 12: Engineering Management or Unit 22: Electronic Circuit and Devices.
To achieve the HNC level 4 qualification, students must achieve 120 credits of completed units in the correct combination with a minimum grade of a Pass in all units.

Module Descriptors

Unit 1: Engineering Design
The aim of this unit is to introduce learners to the methodical steps that engineers use in creating functional products and processes; from a design brief to the work, and the stages involved in identifying and justifying a solution to a given engineering need.

Unit 2: Engineering Maths
The aim of this unit is to develop learner' skills in the mathematical principles and theories that underpin the engineering curriculum. Learners will be introduced to mathematical methods and statistical techniques in order to analyse and solve problems within an engineering context.

Unit 3: Engineering Science
This unit introduces learners to the fundamental laws and applications of the physical sciences within engineering and how to apply this knowledge to find solutions to a variety of engineering problems.

Unit 4: Manging a Professional Engineering Project (Pearson‐set)
This unit introduces learners to the techniques and best practices required to successfully create and manage an engineering project designed to identify a solution to an engineering need. While carrying out this project learners will consider the role and function of engineering in our society, the professional duties and responsibilities expected of engineers together with the behaviours that accompany their actions.

Unit 7: Machining and Processing of Engineering Materials
The aim of this unit is to introduce learners to the application of a variety of material forming processes involved in the production of components and articles for everyday use.

Unit 12: Engineering Management
This unit introduces learners to engineering management principles and practices, and their strategic implementation.

Unit 14: Production Engineering for Manufacture
This unit introduces learners to the production process for key material types; the various types of machinery used to manufacture products and the different ways of organising production systems to optimise the production process; consideration of how to measure the effectiveness of a production system within the overall context of the manufacturing system; and an examination of how production engineering contributes to ensuring safe and reliable operation of manufacturing.

Unit 15: Automation, Robotics and Programmable Logic Controllers (PLCs)
The aim of this unit is for learners to investigate how Programmable Logic Controllers (PLCs) and industrial robots can be programmed to successfully implement automated engineering solutions.

Unit 17: Quality and Process Improvement
This unit introduces learners to the importance of quality assurance processes in a manufacturing or service environment and the principles and theories that underpin them.

Unit 22: Electronic Circuits and Devices
This unit introduces learners to the use of electronics manufacturers' data to analyse the performance of circuits and devices, the operational characteristics of amplifier circuits, the types and effects of feedback on a circuit performance, and the operation and application of oscillators. They will also be introduced to the application of testing procedures to electronic devices and circuits and use the findings of the tests to evaluate their operation.

Unit 23: Computer Aided Design and Manufacture (CAD/CAM)
This unit introduces learners to all the stages of the CAD/CAM process and to the process of modelling components using CAD software specifically suitable for transferring to CAM software.

12. Support for Students and Their Learning

Student progression on course is supported both by subject tutors and central College services and includes:

- An induction programme introducing new students to the subject of study, higher level skills that need to be developed, and the college facilities (including the library, IT facilities, staff and other students).
- College and course/ module handbooks available in print and electronic format on Moodle.
- Personal and academic support is integrated in teaching provided by supportive and accessible tutors and identified 1:1 support sessions are also available.
- A modern library equipped with both electronics and non-electronics books, reading materials, and ICT equipment.
- Study skills sessions integrated in programme.
- Personal development planning sessions integrated into programme
- Up-to-date Computer laboratories with specialist facilities for computer networking and multimedia computing.
- Workshops and laboratories including wind tunnel, flight simulator, automation, and material testing
- Study skills sessions integrated in programme and organised on a regular basis;
- High specification computers with appropriate educational software.
- Planned visits and speakers
- Access to counsellors and support for students with special needs.
- Written assignment / assessment feedback (normally provided with 2 weeks of assessment submission).
- Provision of 1:1 and group tutorial support
- Access to course section and college wide sections on the college's intranet Moodle

13. Criteria for Admission

Full-time and/or Part-Time Entry

Entry Requirements:

Normally, the course enrols students who have reached the minimum age of 18.

Students should have at least:

4 GCSEs grade C/4 or above, plus

1 A-level (80 UCAS Points)

Level 3 Diploma in Engineering (PP), or

Other related Level 3 qualifications may be considered

A GCE Advanced Level profile that demonstrates strong performance in a relevant subject or adequate performance in more than one GCE subject. This profile is likely to be supported by GCSE grades at A* to C and/or 9 to 4 (or equivalent)

Students with existing level 4/5 qualifications may be eligible for some Accreditation for Prior Learning (APL) which can be discussed on an individual basis.

Mature students, over the age of 21, with a suitable background and experience may be accepted without formal qualifications.

Applicants with an Access to Higher Education Certificate awarded by an approved further education institution may be considered.

Applicants with an international equivalent of the above entry qualifications.

Offer of a place is conditional on a successful interview.

14. Progression

After successful completion of the HNC, students can progress onto the second year of the Foundation degree Mechanical Engineering programme – manufacturing pathway, and/or with the higher/degree apprenticeship at Solihull College and University Centre. It may be possible for a student to progress onto other pathways (including BSc (Hons) Degree in Aircraft Maintenance Engineering, and others) within Solihull College and University Centre and/or other local higher education institutions.

Following successful completion of the Foundation Degree at Solihull College and University Centre, students may progress onto the BSc (Hons) top-up degree in Mechanical Engineering at Solihull College and University Centre.

Alternative routes may be available within Solihull College and University Centre and other local universities or colleges on degree programmes or HND programmes.

15. Evaluating the Quality of Teaching and Learning

Evaluation of the Standards of Teaching and Learning is undertaken using the results of the following documents;

- Student feedback questionnaires, both initial impressions and the spring survey
- Module review forms completed by students at the end of every module and summarised by the course leader.
- Student input to the Programme Quality Board held twice a year.
- Student representations made through the HE Student Council.
- Action areas fed by the above to the course based Annual Monitoring report.
- Findings of the peer teaching observation scheme and recommendations for improvement that are made
- Quality Audit of the programme undertaken by Dean of Higher Education & Curriculum Development and an external observer.
- External Verifiers report and audit of assessed work

Students have the opportunity to comment on the quality of the programme in the following ways

- Submitting module evaluation questionnaires which are shared in team meetings and relevant actions raised are included in the Annual Monitoring Review.
- Student Representatives volunteer from each group to bring forward the views of their colleagues informally and within bi-annual programme quality boards (PQB). The minutes of student meetings are placed on Moodle and actions are reviewed at each PQB.

The ways in which the quality of this programme is checked, both inside and outside the college, are:

- External Examiners, who produce an annual report which is available to view on Moodle and also results in an action plan for the following academic year.
- Annual module review in the form of student evaluations which are discussed in a team meeting
- Periodic programme review to identify best practice and invite employers to contribute to the design of the programmes
- Invitation to attend Programme Quality Boards to all students and create a transparent discussion to share ideas, best practice and areas for improvement.

16. Regulation of Assessment

- The programme is the subject of an Annual Monitoring Report (AMR) the last section of which is a Quality Improvement Plan (QIP), written by the course leader with help and input from the teaching and tutoring team this is passed to the Head of School for audit and from them to the quality unit for further audit and acceptance as part of the College plan.
- Assessment rules and regulations and quality standards are those that are laid down in the Quality standards requirements of the College Academic Board.
- Assessment and assessment vehicles are regulated by the internal verification system for each programme which is itself audited by the quality unit within the College and also by the External Verifier appointed by Edexcel.
- External verification of assessment and of the provision and standards of teaching are regulated by Pearson BTEC and their quality unit, the programme has to seek approval for continuance every 5 years. Their requirements are monitored annually by the visit and report of their appointed external verifier (Standards Verifier)
- Also the programme is the subject of periodic review by QAA, ensuring that national benchmarks are met throughout the programme.

Standards Verifiers (External Examiners) are appointed by Pearson

The role of Standards Verifier is that of moderator. In order to do this they check and review:

- action points from previous reports
- Centre assessment policy and boards
- effectiveness of assignments and internal verification
- the maintenance and audit of assessment records
- student registration and certification claims
- student support and review
- areas of good practice

Note:
For further details on regulation of assessments, grading criteria, submissions and resubmissions of assignments, please refer to the BTEC Centre Guide to Enhanced Quality Assurance and Assessment by clicking **online.**

17. Enhancement

- An action plan is provided in each annual programme report and progress in achieving enhancements is reviewed annually.
- Good practice in teaching and learning is developed and disseminated through staff development workshops and through participation in internal verification of completed student work.
- Staff development activities are discussed at annual appraisal interviews and are actively encouraged to develop their professional practice and industrial experience.

18. Programme Resources

The following are the key resources available to support the delivery of the programme:

- Advanced Manufacturing Centre
- Materials Laboratory
- CAD/CAM Software
- PLC Software
- Engineering Workshop
- Mechatronics Workshop

Student Employability

This programme is part of Solihull College and University Centre's commitment to meeting the needs of local, national and international employers by delivering a diverse range of educational models including part-time and work-based study for learners drawn from non-traditional backgrounds in addition to internal progressions from FE vocational programmes.

As part of this commitment, the HNC Manufacturing Engineering programme will:

1. Support students by providing professional, impartial advice and guidance to enable students to make considered career decisions before and during their studies to prepare them for future employment and development by:

    - identifying the skills needed for progression into employment,
    - enhancing their existing employment prospects.

2. Provide subject-related resources and information on local, national and international labour markets;

3. Be responsive to the needs of employers in order to maximise students' employability and career progression prospects;

4. Include study skills which will improve students' academic writing and research capabilities to enable further study and facilitate career progression;

5. Support equality and diversity, and minimise barriers to learning, as described in the college's Equality Policy which can be found on the website under Mission and Policies.

6. Ensure that employers play a key part in module content, course design and assessment criteria by formally seeking their views through individual employer meetings and meetings with industry groups, and the use of a specialist employer service researcher to help to ensure that the course content meets industry expectations and requirements;

Please note: This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided. More detailed information can be found in the programme handbook or online.

Table mapping HNC Manufacturing Engineering Programme learning outcomes across the modules:

Modules	Unit (1)– Engineering Design	Unit (2) – Engineering Maths	Unit (3) – Engineering Science	Unit (4) – Managing a Professional Engineering Project	Unit (7) – Machining and Processing of Engineering Materials	Unit (12) – Engineering Management	Unit (14) – Production Engineering for Manufacture	Unit (15) – Automation, Robotics and Programmable Logic Controllers	Unit (17) – Quality and Business Improvement	Unit (22) – Electronic Circuits and Devices	Unit (23) – Computer Aided Design and Manufacture (CAD/CAM)
3.1 Academic Literacy											
1.1	x	x	x	x	x	x	x	x	x	x	x
1.2	x	x	x	x	x	x	x	x	x	x	x
1.3	x	x	x	x	x	x	x	x	x	x	x
3.2 Research Literacy											
2.1	x	x	x	x	x	x	x	x	x	x	x
2.2	x			x	x	x	x		x	x	
2.3	x	x	x	x	x	x	x	x	x	x	x
2.4	x		x	x		x	x	x			x
2.5	x	x	x	x	x	x	x	x	x	x	
2.6	x			x	x	x	x		x	x	
3.3 Critical self–awareness and personal literacy											
3.1				x	x	x	x		x	x	
3.2				x	x	x	x		x	x	
3.3				x		x	x				
3.4	x			x		x	x				
3.4 Digital and Information Literacy											
4.1	x			x	x	x	x	x	x	x	x
4.2	x	x	x	x	x	x	x	x	x	x	x
4.3	x	x	x	x	x	x	x	x	x	x	
4.4	x		x	x	x	x	x	x	x	x	x
3.5 Active Citizenship											
5.1	x	x	x	x	x	x	x	x	x	x	x
5.2	x			x	x	x	x	x	x	x	x
5.3	x			x	x	x	x	x	x	x	x
5.4	x			x	x	x	x		x	x	
5.5	x	x	x	x	x	x	x	x	x	x	x
5.6	x	x	x	x	x	x	x	x	x	x	x
MANDATORY/CORE (BOTH PATHWAYS)				MANUFACTURING ENGINEERING CORE				OPTIONS			

The UK-Spec Learning Outcomes are covered in the programme as follows (definition of UK-Spec Learning Outcomes can be found, for example, in the IET handbook of Learning outcomes http://www.engc.org.uk/engcdocuments/internet/Website/UK-SPEC%20third%20edition%20%281%29.pdf):

Modules	US1i	US2i	E1i	E2i	E3i	E4i	D1i	D2i	D4i	D5i	D6i	P1i	P2i	P3i	P4i	P6i	P7i	P8i
Unit (1) – Engineering Design	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Unit (2)– Engineering Maths	x	X		X	X							X		X				
Unit (3) – Engineering Science	x	X		X	X							X	X	X	X			
Unit (4) – Project Design, Implementation and Evaluation	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Unit (7) – Machining and Processing of Engineering Materials	x	x		x	x							x		x				
Unit (12) – Engineering Management			X	X								X		X	X		X	
Unit (14) – Production Engineering for Manufacture	x	x		x	x							x		x				
Unit (15) – Automation, Robotics and Programmable Logic Controllers	X	X	X	X	X	X						X	X	X	X			
Unit (17) – Quality and Process Improvement			X	X								X		X	X	X	X	
Unit (22) – Electronic Circuit and Devices	X	X		X	X	X						X	X		X			
Unit (23) – Computer Aided Design and Manufacture (CAD/CAM)	X		X		X	X	X	X	X		X	X	X	X	X	x		

1. Academic literacy

Learners are expected to have academic literacy of:

1.1. Mechanical and Manufacturing Engineering, so that they are able to demonstrate the knowledge and understanding to deal with well-established, and with some depth, facts, concepts, principles & theories relevant to Mechanical and Manufacturing Engineering, within a broad engineering subject base (UK-SPEC A1, A2: Output[1] US1i, S1i, P6i).

1.2. Complexity within Mechanical and Manufacturing Engineering systems, informed by literature & resources which are largely prescribed (UK-SPEC A1, A2: Output P4i, P5i).

1.3. The inter-relationships of health & safety, design, engineering science & applications, analytical & mathematical techniques, environmental considerations & sustainability,

[1] The definition of UK-Spec Outputs can be found, for example, in the IET handbook of Learning outcomes http://www.theiet.org/academics/accreditation/policy-guidance/handbook_lo.cfm

systems, management and economic factors in relation to Mechanical and Manufacturing Engineering (Output US2i, D1i, S1i, S2i, S3i, S4i, P6i).

2. Research literacy

Learners are expected to have research literacy so that they can:

2.1. Apply aspects of relevant facts, concepts, principles & theories relevant to Mechanical and Manufacturing Engineering issues to their subject and / or professional work areas (UK-SPEC A1, A2: Output US1i, US2i, S1i, P6i).
2.2. Make and justify decisions relevant to design, manufacture, use and decommissioning of mechanical equipment and / or plant including preventative measures which are specified and predictable; and produce an action plan, where appropriate, supported by pertinent evidence (UK-SPEC A2, B2: Output E1i, E3i, D3i, D4i, D5i).
2.3. With guidance, in relation to the field of Mechanical and Manufacturing Engineering and within specified parameters, explain key engineering principles and identify their relevance and significance to Mechanical and Manufacturing Engineering and justify their application to specific problems which are specified and produce a coherent line of argument supported by relevant evidence (UK-SPEC B1: Output E1i, E2i, E3i, P4i).
2.4. Identify, explain and use appropriate practical and laboratory skills with the appropriate selection of experimental and investigative techniques (Output P1i, P2i).
2.5. Identify, access, use, explain and evaluate information / data which is relevant from a range of sources (Output P4i).
2.6. Set milestones within a given plan and implement plan to achieve several objectives (UK-SPEC C1: Output S2i).

3. Critical self-awareness and personal literacy

Learners are expected to have critical self-awareness and personal literacy so that they can:

3.1. Undertake prescribed independent study techniques and their application to work-based learning including the setting of goals, managing time appropriately and prioritising tasks, and review personal performance to ensure that work is completed in a timely manner.
3.2. In relation to the professional work area, operate effectively in situations that are largely straightforward and predictable within practical / employment / work contexts requiring the exercise of personal responsibility and/or decision-making as evidenced by work-based learning in the application of underlying concepts and principles of Mechanical and Manufacturing Engineering in routine and novel situations (UK-SPEC C1, C2, E2: Output D3i, P3i, P4i).
3.3. In relation to the learner's professional area and with clear guidance / support, participate effectively in appropriate collaboration with people from other disciplines / professions (UK-SPEC C3, D3: Output P3i).
3.4. For a given situation and audience, communicate knowledge and understanding appropriate to the level in an appropriate written, verbal or visual format in a way that is appropriate for the purpose, topic and situation and in such a way as to demonstrate understanding to academic, specialist and non-specialist audiences (UK-SPEC D1: Generic Output).

4. Digital and information literacy

Learners are expected to have digital and information literacy so that they can:

4.1. With guidance, in relation to academic and practical work, convey information which has some complexity in written/spoken English which is accurate and clear in terms of grammar / syntax / vocabulary-choice / style and use academic conventions appropriately for the purpose, topic, situation and audience and also reference a range of different types of sources accurately in line with guidance provided (Generic Output).
4.2. Select and use specified IT applications and strategies as appropriate for guided purposes and tasks and the retrieval of information (Output E2i, P1i).
4.3. Solve straightforward contextual, qualitative and numerical problems by identifying, explaining and selecting appropriate approaches to use and also evaluate both the approaches and solutions to the problem (Output E2i, E3i).
4.4. Critically evaluate the validity and implications of information relevant to Mechanical and Manufacturing Engineering and their work practice (Generic Output).

5. Active citizenship

Learners are expected to have active citizenship so that they can:

5.1. With guidance, in relation to the field of Mechanical and Manufacturing Engineering and within specified parameters, identify and explain issues related to health and safety, design, engineering science & applications, analytical & mathematical techniques, environmental considerations & sustainability, systems, management and economic factors (UK-SPEC E2, E3: Output E4i, D1i, D2i, D5i, S4i).

5.2. With guidance, in relation to the field of Mechanical and Manufacturing Engineering and within specified parameters, evaluate and critically analyse mechanical equipment and systems and make suggestions to improve the design life, performance and efficiency and justify decisions about the management of mechanical equipment and systems and also related technologies (UK-SPEC B3, C4: Output E1i, E2i, E3i, E4i, D4i, D5i, P7i).

5.3. Demonstrate respect for the perspective of other disciplines / professions and be able to identify the potential contribution of own and other professions / disciplines to the area of practice and describe the purpose of these disciplines / professions and their role within a multidisciplinary team (UK-SPEC C3, D3: Output P3i).

5.4. In relation to Engineering, with clear guidance & support, appropriately work effectively within the boundaries imposed by ethical and legal issues (including standards & codes) and demonstrate respect for the ethical and legal boundaries of other disciplines (UK-SPEC E1, E2: Output S4i, S5i, P3i, P5i).

5.5. Demonstrate the learning ability needed to undertake further training, develop existing skills, and acquire new competences that will enable them to assume significant responsibility within organisations (UK-SPEC A1, E4: Generic Output).

5.6. Reflect, selecting from a range of suggested approaches and techniques, and seek and use feedback to inform reflection on and analysis of own strengths, limitations & performance and identify their implications (UK-SPEC D3: Generic Output).

	IEng degree as an enhancement or limitation to BEng (Hons) for CEng		BEng (Hons) for CEng		Integrated MEng degree as enhancement of BEng (Hons)
	The weighting given to these different broad areas of learning will vary according to the nature and aims				
	Underpinning Science and Mathematics and associated engineering disciplines (US)				
US1i	• Knowledge and understanding of the scientific principles underpinning relevant technologies, and their evolution	**US1**	• 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 future developments and technologies.	**US1m**	• A comprehensive understanding of the scientific principles of own specialisation and related disciplines.
US2i	• Knowledge and understanding of mathematics necessary to support application of key engineering principles	**US2**	• 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.	**US2m**	• A comprehensive knowledge and understanding of mathematical and computer models relevant to the engineering discipline, and an appreciation of their limitations.
US3		**US3**	• Ability to apply and integrate knowledge and understanding of other engineering disciplines to support the study of their own engineering discipline	**US3m**	• An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.
				US4m	• An awareness of developing related to own specialisation.

IEng degree		BEng(Hons) for CEng		Integrated MEng degree	
	Engineering Analysis (E)				
E1i	• Ability to monitor, interpret and apply the results of analyses and modelling in order to bring about continuous improvement	**E1**	• Understanding of engineering principles and the ability to apply them to analyse key engineering processes.	**E1m**	• Ability to use fundamental knowledge to investigate new and emerging technologies.
E2i	• Ability to use the results of analysis to solve engineering problems, apply technology and implement engineering processes.	**E2**	• Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques	**E2m**	• Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate
E3i	• Ability to apply quantitative methods and computer software relevant to their engineering technology discipline(s), frequently within a multidisciplinary context.	**E3**	• Ability to apply quantitative methods and computer software relevant to their engineering discipline, to solve engineering problems	**E3m**	• Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.
E4i	• Ability to apply a systems approach to engineering problems through know-how of the application of the relevant technologies	**E4**	• Understanding of and ability to apply a systems approach to engineering problems	**E4**	

	IEng degree		BEng(Hons) for CEng		Integrated MEng degree
	Design is the creation and development of an economically viable product, process or system to meet a defined need. It involves significant technical and intellectual challenges and can be used to integrate all engineering understanding, knowledge and skills to the solution of real problems. Graduates need the knowledge understanding and skills to:				
	Design (D)				
D1i	• Define a problem and identify constraints.	**D1**	• Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues	**D1m**	• Wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.
D2i	• Design solutions according to customer and user needs	**D2**	• Understand customer and user needs and the importance of considerations such as aesthetics	**D2**	
D3		**D3**	• Identify and manage cost drivers	**D3**	
D4i	• Use creativity and innovation in a practical context	**D4**	• Use creativity to establish innovative solutions	**D4m**	• Ability to generate an innovative design for products, systems, components or processes to fulfil new needs.
D5i	• Ensure fitness for purpose (including operation, maintenance, reliability etc)	**D5**	• Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal	**D5m**	
D6i	• Adapt designs to meet their new purposes or applications	**D6**	• Manage the design process and evaluate outcomes	**D6**	

IEng degree		BEng(Hons) for CEng		Integrated MEng degree	
Economic, social and environmental context (S)					
S1		**S1**	• Knowledge and understanding of commercial and economic context of engineering processes	**S1m**	• The ability to make general evaluations of commercial risks through some understanding of the basis of such risks
S2		**S2**	• Knowledge of management techniques which may be used to achieve engineering objectives within that context	**S2m**	• Extensive knowledge and understanding of management and business practices, and their limitations, and how these may be applied appropriately *to strategic and tactical issues.*
S3		**S3**	• Understanding of the requirement for engineering activities to promote sustainable development	**S3**	
S4		**S4**	• Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues.	**S4**	
S5		**S5**	• Understanding of the need for a high level of professional and ethical conduct in engineering	**S5**	

	IEng degree		BEng(Hons) for CEng		Integrated MEng degree
	Practical application of engineering skills, combining theory and experience, and use of other relevant knowledge and skills. This must include an appropriate combination of the majority of these outcomes				
	Engineering Practice (P)				
P1i	• Understanding of and ability to use relevant equipment, tools, processes, or products	**P1**	• Knowledge of characteristics of particular equipment, processes or products	**P1m**	• A thorough understanding of current practice and its limitations and some appreciation of likely new developments
P2i	• Knowledge and understanding of workshop and laboratory practice	**P2**	• Workshop and laboratory skills	**P2m**	• Extensive knowledge and understanding of a wide range of engineering materials and components
P3i	• Knowledge of contexts in which engineering knowledge can be applied (e.g. operations and management, application and development of technology, etc)	**P3**	• Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc)	**P3**	
P4i	• Ability to use and apply information from technical literature	**P4**	• Understanding use of technical literature and other information sources	**P4**	
P5		**P5**	• Awareness of nature of intellectual property and contractual issues	**P5**	
P6i	• Ability to use appropriate codes of practice and industry standards	**P6**	• Understanding of appropriate codes of practice and industry standards	**P6**	
P7i	• Awareness of quality issues and their application to continuous improvement	**P7**	• Awareness of quality issues	**P7**	
P8i	• Understanding of the principles of managing engineering processes	**P8**	• Ability to work with technical uncertainty	**P8m**	• Ability to apply engineering techniques taking account of a range of commercial and industrial constraints

Document History

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3.

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