

**Programme Specification**

**Title of Courses:**

* MEng Mechanical Engineering
* MEng Mechanical Engineering with Professional Placement
* MEng Mechanical Engineering (Automotive Engineering)
* MEng Mechanical Engineering (Automotive Engineering) with Professional Placement

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| Date first produced | July 2017 |
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| Date of implementation of current version | June 2023 |
| Version number | V3 |
| Faculty | Faculty of Engineering, Computing and the Environment |
| School | School of Engineering and the Environment |
| Department | Department of Mechanical Engineering |
| Delivery Institution | Kingston University |

This Programme Specification is designed for prospective students, current students, academic staff and employers. It provides a concise summary of the main features of the programme and the intended learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if they take full advantage of the learning opportunities that are provided. More detailed information on the learning outcomes and content of each module can be found in the course VLE site and in individual Module Descriptors.

**SECTION 1: GENERAL INFORMATION**

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| Award(s) and Title(s): | * MEng Mechanical Engineering * MEng Mechanical Engineering with Professional Placement * MEng Mechanical Engineering (Automotive Engineering) * MEng Mechanical Engineering (Automotive Engineering) with Professional Placement |
| Intermediate Awards(s) and Title(s): | * Certificate of Higher Education in Mechanical Engineering * Certificate of Higher Education in Mechanical Engineering (Automotive Engineering) * Diploma of Higher Education in Mechanical Engineering * Diploma of Higher Education in Mechanical Engineering (Automotive Engineering) * BEng (Hons) Mechanical Engineering * BEng (Hons) Mechanical Engineering (Automotive Engineering) |
| FHEQ Level for the Final Award: | Level 7 |
| Awarding Institution: | Kingston University |
| Teaching Institution: | Kingston University |
| Location: | Roehampton Vale Campus, London |
| Language of Delivery: | English |
| Modes of Delivery: | Full time; Sandwich with Professional Placement |
| Available as: | Full Field |
| Minimum period of registration: | Full Time 4 Years; Sandwich 5 years |
| Maximum period of registration: | Full Time 8 Years; Sandwich 8 Years |
| Entry Requirements: | The minimum entry qualifications for the programme are:  From A levels: 128 points to include A2 mathematics at grade B plus two suitable science subjects.  BTEC National: Distinction, Distinction, Distinction (DDD) from an engineering-related BTEC Extended Diploma including Merit for Mathematics and Further Mathematics.    Access Diploma: 144 points at level 3 including Distinction and Maths, Mechanics and Science modules.  Plus: GCSE (A\*-C) minimum of 5 subjects including English Language and Mathematics.  Entry is normally at Level 4 (Year 1) with A-level or equivalent qualifications as specified above. An Engineering Foundation course with pathways in Mechanical Engineering and Automotive Engineering is available. Transfer from a similar course is possible at Level 5 with passes in comparable Level 4 modules – but is at the discretion of the course team. Intake is normally in September.  Students may transfer into Level 6 of the MEng after successfully completing Level 5 of the BEng (Hons) Mechanical Engineering or BEng (Hons) Mechanical Engineering (Automotive Engineering) provided they have achieved B- average in Level 5.  Direct entry to Level 5 of the MEng is not normally permitted. The preferred route is to admit students on to Level 5 of the BEng (Hons) and then to transfer to Level 6 of the MEng provided they meet the provisions of the previous paragraph.  Consideration will also be given to a range of alternative qualifications or experience that is equivalent to the typical offer. Applications from international students with equivalent qualifications are welcome. |
| Programme Accredited by: | Institution of Mechanical Engineers (IMechE):   * EngC ref 1330: MEng Mechanical Engineering * EngC ref 16901: MEng Mechanical Engineering with Professional Placement * EngC ref 16904: MEng Mechanical Engineering (Automotive Engineering) * EngC ref 16905: MEng Mechanical Engineering (Automotive Engineering) with Professional Placement |
| QAA Subject Benchmark Statements: | QAA subject benchmark statements can be found [here](https://www.qaa.ac.uk/quality-code/subject-benchmark-statements). |
| Approved Variants: | * Where a module has more than one element of assessment, in addition to the normal requirement that a student must pass the module on aggregate, there are additional requirements for the student to pass elements of assessment in the module separately in order to achieve an overall pass for the module. Such additional module-specific requirements are outlined in the Module Descriptors. * To comply with the Engineering Council regulations, a maximum of 30 credits in the programme can be compensated. |
| UCAS Code: | * H303: MEng Mechanical Engineering * H304: MEng Mechanical Engineering with Professional Placement * H323: MEng Mechanical Engineering (Automotive Engineering) * H324: MEng Mechanical Engineering (Automotive Engineering) with Professional Placement |

**SECTION 2: THE COURSE**

**Aims of the Course**

The general aim of the Mechanical Engineering course, including the Automotive Engineering pathway, is to equip graduates with the engineering, design, management, business and personal skills required to become professional mechanical/automotive engineers, as well as enabling them to follow careers in related professional disciplines.

More specific aims of the course are:

* To develop students’ analytical and problem-solving abilities, enabling them to evaluate evidence and assumptions critically, make informed decisions, and communicate their findings effectively.
* To equip students with the research skills required for postgraduate studies and the employability skills essential for work in mechanical engineering and related industries.
* To produce graduates with an in-depth knowledge and understanding of the key aspects of mechanical/automotive engineering.
* To prepare graduates to approach design problems creatively and to possess the technical skills necessary to realise these solutions.
* To furnish graduates with a comprehensive understanding of sustainability and health and safety principles within the context of their discipline.
* To provide graduates with reflective skills to recognise the importance of continuous self-development in applying their professional judgment.
* To ensure that graduates possess the ability and confidence to assume leadership roles in major engineering projects.
* To provide students with multidisciplinary skills and knowledge by offering common modules throughout the programme.
* To furnish students with the leadership skills and knowledge required to generate new knowledge through research and development, as required for chartered engineers.

**Intended Learning Outcomes**

The programme outcomes are referenced to the QAA subject benchmarks for Engineering (2023) and the Framework for Higher Education Qualifications of

Degree-Awarding Bodies in England, Wales and Northern Ireland (2014), and relate to the typical student. The programme provides opportunities for students to develop and demonstrate knowledge and understanding specific to the subject, key skills and graduate attributes in the following areas:

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| **Programme Learning Outcomes** | | | | | |
|  | **Knowledge and Understanding**  On completion of the course students will be able to: |  | **Intellectual Skills**  On completion of the course students will be able to |  | **Subject Practical Skills**  On completion of the course students will be able to |
| A1 | Apply a comprehensive knowledge of core mechanical engineering subjects of statics, dynamics, materials, thermodynamics, fluid mechanics and design to the solution of complex problems in mechanical engineering | B1 | Formulate and analyse complex mechanical engineering problems to reach substantiated conclusions | C1 | Use practical laboratory and workshop skills to investigate and test mechanical systems and components |
| A2 | Identify and apply engineering concepts in design, analysis and optimisation of mechanical systems | B2 | Select and apply appropriate computational and analytical techniques to model mechanical systems and processes, discussing the limitations of the techniques employed | C2 | Select and apply appropriate materials, equipment, engineering technologies and processes for manufacturing and assembling mechanical components and systems, recognising their limitations |
| A3 | Develop an understanding of the mechanical behaviour of materials and apply this knowledge to the design of components and structures | B3 | Select and critically evaluate technical literature and other sources of information to solve mechanical engineering problems | C3 | Design and conduct experiments to validate and optimise mechanical systems and components, interpreting and presenting data in a clear and concise manner |
| A4 | Apply knowledge of thermodynamics and fluid mechanics to analyse and design thermal and fluid systems | B4 | Design mechanical systems that meet desired specifications and constraints, while considering factors such as safety, reliability and cost | C4 | Develop practical skills to prototype and test mechanical systems, ensuring their effectiveness, reliability and safety |
| A5 | Demonstrate knowledge of manufacturing processes and materials selection, recognising their limitations | B5 | Identify and analyse ethical concerns related to mechanical engineering projects and make reasoned ethical choices informed by professional codes of conduct | C5 | Function effectively as an individual, and as a member or leader of a team, evaluating the effectiveness of own and team performance |
| A6 | Evaluate the environmental impact of mechanical systems and design solutions that minimise adverse impacts | B6 | Use a risk management process to identify, evaluate and mitigate risks associated with mechanical engineering projects or activities | C6 | Communicate effectively on mechanical engineering matters with technical and non-technical audiences, evaluating the effectiveness of the methods used |
| A7 | Develop a critical awareness of new developments in the field of mechanical engineering and their potential impact on industry and society | B7 | Adopt an inclusive approach to engineering practice and recognise the responsibilities, benefits and importance of supporting equality, diversity, and inclusion in mechanical engineering projects and activities. | C7 | Adopt a holistic and proportionate approach to the mitigation of security risks associated with mechanical engineering projects and activities |

In addition to the programme learning outcomes identified overleaf, the programme of study defined in this programme specification will allow apprentices to develop a range of Key Graduate Attribute and Personal Development Skills in line with the Kinston University’s Championing Future Skills:

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| **Graduate Attribute and Personal Development Skills and the Associated Skills and Competencies** | | | | | | | | |
| **Questioning Mindset** | **Creative Problem Solving** | **Collaboration** | **Empathetic** | **Digital Competency** | **Adaptability** | **Resilience** | **Enterprising** | **Self-Aware** |
| **Curiosity** – good at showing an interest in learning about the people or things around me | **Creativity** – good at using my imagination to produce original ideas | **Communication** – good at expressing ideas effectively and confidently in speech, writing and other media, to multiple audiences | **Cross-cultural communication** – good at communicating effectively with people from different cultural backgrounds | **Digital Literacy** – good at using information and communication technologies to find, evaluate, create, and communicate information safely online | **Agility** – good at understanding new ideas, concepts, and situations quickly | **Growth Mindset** – good at recognising that personal abilities can be developed through dedication, hard work and continuous learning | **Entrepreneurial thinking** – good at identifying unexploited opportunities and making the most of them | **Reflective Thinking** – good at carefully thinking about an experience and learning from it for the future |
| **Active Listening** – good at paying attention to and effectively interpreting what others are saying | **Decision Making** – good at evaluating options and determining the best course of action based on facts and logic | **Conflict Management** – good at dealing with conflict in a positive and constructive way to find a mutually agreeable solution | **Cultural Intelligence** – good at working effectively with diverse individuals, demonstrating an interest in cultures other than my own | **Digital Citizenship** – good at engaging positively, critically and competently in the digital environment | **Opportunity Recognition** – good at identifying and seeking out new opportunities for development and growth | **Perseverance** - good at continuing doing something or moving forward in spite of obstacles | **Innovation** – good at demonstrating original ideas and thinking | **Values Informed** – good at identifying the things that I believe are important in my life and work, and living true to them in my actions |
| **Analytical Thinking** – good at analysing information and making reasoned judgements | **Critical Thinking** – good at questioning and challenging information to make reasoned judgements | **Negotiation** – good at discussing an issue and determining ways to reach an agreement to mutual satisfaction | **Perspective Taking** – good at perceiving a situation from the perspective of another person | **Digital Productivity** – good at utilising a range of digital technologies to work smarter, supporting efficiency and effectiveness | **Open-minded** – good at considering ideas and opinions new or different to my own | **Stress Management** – good at applying a range of strategies and tools to support stress reduction | **Networking** – good at making contacts and building good relationships | **Mindful** – good at being aware of my behaviours and considering the consequences on others |

In addition to the programme learning outcomes identified overleaf, the programme of study defined in this programme specification will allow students to develop the following range of Graduate Attributes:

1. Creative Problem Solving
2. Digital Competency
3. Enterprise
4. Questioning Mindset
5. Adaptability
6. Empathy
7. Collaboration
8. Resilience
9. Self-Awareness

**Outline Programme Structure**

The undergraduate mechanical engineering programme at Kingston University consists of four main themes, each of which is designed to provide a comprehensive understanding of mechanical/automotive engineering principles and practices. The first theme is focused on developing a deep understanding of the principles of engineering science such as thermodynamics, mechanics of solid and materials and fluid mechanics, which are essential for solving complex engineering problems related to the behaviour of materials and mechanical systems. The second theme aims to broaden students’ knowledge base by introducing them to topics such as electrical and electronic systems, engineering mathematics, programming and computing. The third theme is dedicated to introducing students to the professional practice of mechanical/automotive engineering, covering topics such as project management, quality assurance, and business management. Finally, the programme incorporates a strong design theme that is woven throughout all the other themes, emphasising the holistic nature of modern-day engineering. By developing skills in materials, manufacturing processes, communication, and problem-solving, students will be well-equipped to meet the needs of the future workforce.

Our programme design is based on the guidelines provided by the Engineering Council UK Standard for Professional Engineering Competence (UK-SPEC), the Quality Assurance Agency (QAA) Subject Benchmark Statement for Engineering, and the Institution of Mechanical Engineers (IMechE) Academic Accreditation.

Our Mechanical Engineering degrees have been accredited by the IMechE. This accreditation signifies that our programmes adhere to the highest standards of education and provide a clear pathway towards achieving Chartered Engineer status. The MEng courses fully meet the exemplifying academic benchmark requirements for registration as a Chartered Engineer (CEng). The University provides students with relevant regulations and specific requirements for accreditation by external professional or statutory bodies.

To complete their degree, students are typically required to complete 120 credits at each level. During their first year (also known as Level 4), both mechanical engineering and automotive engineering pathway students will take a set of six modules, consisting of four 15-credit modules and two 30-credit modules. Table below provides an overview of the programme’s structure. Full details of each module will be provided in individual Module Descriptors and student Module Guides. The list of modules provided below is only indicative and may include both core and optional modules.

Note: The Formula Student Fundamentals is a non-credit bearing module which is offered in the first year (Level 4) introducing students to the Formula Student programme through a self-paced curriculum consisting of pre-recorded video content. The module is pass/fail and can be excluded from a student’s transcript if they choose not to participate. As per [GR5](https://www.kingston.ac.uk/aboutkingstonuniversity/howtheuniversityworks/policiesandregulations/#blockid21000) within the general regulations, the University aims to ensure that all option modules listed below are delivered. However, for various reasons, such as demand, the availability of option modules may vary from year to year or between teaching blocks. The University will notify students by email as soon as these circumstances arise.

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| **Level** | **Module Credit** | **Module Title** | **MEng Mechanical Engineering** | **MEng Mechanical Engineering with Professional Placement** | **MEng Mechanical Engineering (Automotive Engineering)** | **MEng Mechanical Engineering (Automotive Engineering) with Professional Placement** |
| **Level 4** | 15 | Navigate for the Professional Engineer | û | û | û | û |
| 15 | Engineering Mathematics | û | û | û | û |
| 15 | Programming for Engineers | û | û | û | û |
| 15 | Thermodynamics and Fluid Mechanics | û | û | û | û |
| 30 | Engineering Mechanics and Materials | û | û | û | û |
| 30 | Engineering Design and Manufacture | û | û | û | û |
| 0 | Formula Student Fundamentals | û | û | û | û |
| **Level 5** | 15 | Exploring Engineering Project Management | û | û | û | û |
| 15 | Numerical Analysis and Computing | û | û | û | û |
| 15 | Thermofluids | û | û |  |  |
| 15 | Solid Mechanics and Vibration | û | û |  |  |
| 15 | Vehicle Dynamics and Suspension |  |  | û | û |
| 15 | Automotive Powertrain Systems |  |  | û | û |
| 30 | Electronic and Control Systems | û | û | û | û |
| 30 | Computer-Aided Engineering | û | û |  |  |
| 30 | Automotive Design Team Project |  |  | û | û |
|  | 60 | Industrial Placement |  | û |  | û |
| **Level 6** | 15 | Applied Business Management | û | û | û | û |
| 15 | Microcontrollers | û | û | û | û |
| 15 | Fluid Dynamics and Thermal Systems | û | û |  |  |
| 15 | Dynamics and Control | û | û |  |  |
| 15 | High Performance Vehicle Aerodynamics |  |  | û | û |
| 15 | Automotive Design and Structural Analysis |  |  | û | û |
| 30 | Machine Design with Finite Element Method | û | û | û | û |
| 30 | Individual Project | û | û | û | û |
|  | 60 | Industrial Placement  (If not undertaken between Levels 5 and 6) |  | û |  | û |
| **Level 7** | 15 | Electrification Technology in Automotive Industry | û | û | û | û |
| 15 | Machine Learning | û | û |  |  |
| 15 | Additive Manufacturing | û | û |  |  |
| 15 | Structural Integrity and Failure Analysis | û | û |  |  |
| 15 | Automotive Aerodynamics and Structural Analysis |  |  | û | û |
| 15 | Advanced Control Systems |  |  | û | û |
| 15 | Engineering and Business Resource Management |  |  | û | û |
| 30 | Product Design Lifecycle Analysis | û | û | û | û |
| 30 | MEng Team Project | û | û | û | û |

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| **Level 4** | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Navigate for the Professional Engineer | ME4021 | 15 | 4 | 1 |
| Engineering Mathematics | EG4017 | 15 | 4 | 1 |
| Programming for Engineers | EG4016 | 15 | 4 | 2 |
| Thermodynamics and Fluid Mechanics | EG4024 | 15 | 4 | 2 |
| Engineering Mechanics and Materials | EG4019 | 30 | 4 | 1 & 2 |
| Engineering Design and Manufacturing | EG4023 | 30 | 4 | 1 & 2 |
| **Optional Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Formula Student Fundamentals | ME4222 | 0 | 4 | 1 & 2 |

The programme permits progression from Level 4 to Level 5 with 90 credits at Level 4 or above. The outstanding 30 credits from Level 4 can be trailed into Level 5 and must be passed before progression to Level 6. Students exiting the course at this point who have successfully completed 120 credits at Level 4 or above are eligible for the award of Certificate of Higher Education in either Mechanical Engineering or Mechanical Engineering (Automotive Engineering), depending on their chosen programme of study.

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| **Level 5 (all core)** | | | | |
| Courses:   * BEng (Hons) Mechanical Engineering * BEng (Hons) Mechanical Engineering with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Numerical Analysis and Computing | EG5015 | 15 | 5 | 1 |
| Thermofluids | ME5015 | 15 | 5 | 1 |
| Exploring Engineering Project Management | EG5016 | 15 | 5 | 2 |
| Solid Mechanics and Vibration | ME5016 | 15 | 5 | 2 |
| Electronic and Control Systems | ME5017 | 30 | 5 | 1 & 2 |
| Computer-Aided Engineering | ME5018 | 30 | 5 | 1 & 2 |
| Courses:   * BEng (Hons) Mechanical Engineering (Automotive Engineering) * BEng (Hons) Mechanical Engineering (Automotive Engineering) with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Numerical Analysis and Computing | ME5015 | 15 | 5 | 1 |
| Vehicle Dynamics and Suspension | ME5019 | 15 | 5 | 1 |
| Exploring Engineering Project Management | EG5016 | 15 | 5 | 2 |
| Automotive Powertrain Systems | ME5020 | 15 | 5 | 2 |
| Electronic and Control Systems | ME5017 | 30 | 5 | 1 & 2 |
| Automotive Design Team Project | ME5022 | 30 | 5 | 1 & 2 |

This programme permits progression from Level 5 to Level 6 with 90 credits at Level 5 or above. The outstanding 30 credits from Level 5 can be trailed into Level 6 and must be passed before consideration for an award or progression to level 7. Students exiting the programme at this point who have successfully completed 120 credits at Level 5 or above are eligible for the award of Diploma of Higher Education in either Mechanical Engineering or Mechanical Engineering (Automotive Engineering), depending on their chosen programme of study.

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| **Placement Year** | | | | |
| Courses:   * MEng Mechanical Engineering with Professional Placement * MEng Mechanical Engineering (Automotive Engineering) with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Industrial Placement | CI5999 | 60 | 5 | 1 & 2 |

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| **Level 6 (all core)** | | | | |
| Courses:   * BEng (Hons) Mechanical Engineering * BEng (Hons) Mechanical Engineering with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Applying Business Management | EG6026 | 15 | 6 | 1 |
| Microcontrollers | ME6017 | 15 | 6 | 1 |
| Fluid Dynamics and Thermal Systems | ME6018 | 15 | 6 | 2 |
| Dynamics and Control | EG6027 | 15 | 6 | 2 |
| Machine Design with Finite Element Method | ME6019 | 30 | 6 | 1 & 2 |
| Individual Project | ME6020 | 30 | 6 | 1 & 2 |
| Courses:   * BEng (Hons) Mechanical Engineering (Automotive Engineering) * BEng (Hons) Mechanical Engineering (Automotive Engineering) with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Applied Business Management | EG6026 | 15 | 6 | 1 |
| Microcontrollers | ME6017 | 15 | 6 | 1 |
| High Performance Vehicle Aerodynamics | ME6022 | 15 | 6 | 2 |
| Automotive Design and Structural Analysis | ME6023 | 15 | 6 | 2 |
| Machine Design with Finite Element Method | ME6019 | 30 | 6 | 1 & 2 |
| Individual Project | ME6020 | 30 | 6 | 1 & 2 |

This programme permits progression from Level 6 to Level 7 with 90 credits at Level 6 or above. The outstanding 30 credits from Level 6 can be trailed into Level 7 and must be passed before consideration for an award. Students who choose to exit the programme at this point and have completed a total of 120 credits at Level 6 will be eligible for the award of BEng (Hons) degree in either Mechanical Engineering or Mechanical Engineering (Automotive Engineering), depending on their chosen programme of study.

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| **Placement Year (**If not undertaken between Levels 5 and 6) | | | | |
| Courses:   * MEng Mechanical Engineering with Professional Placement * MEng Mechanical Engineering (Automotive Engineering) with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Industrial Placement | CI5999 | 60 | 6 | 1 & 2 |

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| **Level 7 (all core)** | | | | |
| Courses:   * MEng Mechanical Engineering * MEng Mechanical Engineering with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Machine Learning | ME7016 | 15 | 7 | 1 |
| Additive Manufacturing | ME7017 | 15 | 7 | 1 |
| Structural Integrity and Failure Analysis | ME7018 | 15 | 7 | 2 |
| Electrification Technology in Automotive Industry | ME7019 | 15 | 7 | 2 |
| Product Design Life Cycle Analysis | ME7020 | 30 | 7 | 1 & 2 |
| MEng Team Project | ME7021 | 30 | 7 | 1 & 2 |
|  | | | | |
| Courses:   * MEng Mechanical Engineering (Automotive Engineering) * MEng Mechanical Engineering (Automotive Engineering) with Professional Placement | | | | |
| **Core Modules** | **Module Code** | **Credit**  **Value** | **Level** | **Teaching Block** |
| Automotive Aerodynamics and Structural Analysis | ME7022 | 15 | 7 | 1 |
| Advanced Control Systems | ME7023 | 15 | 7 | 1 |
| Electrification Technology in Automotive Industry | ME7019 | 15 | 7 | 2 |
| Engineering and Business Resource Management | ME7024 | 15 | 7 | 2 |
| Product Design Life Cycle Analysis | ME7020 | 30 | 7 | 1 & 2 |
| MEng Team Project | ME7021 | 30 | 7 | 1 & 2 |

To be awarded an MEng degree, students must pass all 480 credits.

## Principles of Teaching, Learning and Assessment

The undergraduate mechanical engineering programme has been crafted with Kingston University’s Curriculum Design Principles in mind, to cultivate graduates who are not only proficient in their field but also possess a range of valuable qualities such as professionalism, creativity, resilience, proactivity, global awareness, independence, and the ability to learn continuously throughout their lives. By incorporating sustainability into its activities, the programme aims to help prepare graduates to address the pressing environmental and social challenges of our time. The key United Nations Sustainable Development Goals that the programme contributes to include:

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We believe that every student’s learning experience is unique, and we strive to provide an inclusive curriculum that acknowledges and accommodates students’ circumstances. Our Navigate programme, which is integrated into each year of our courses and aligned with Kingston University’s Future Skills Student Journey, aims to cultivate the essential communication, problem-solving, and creative thinking skills that employers highly value.

At Level 4 of the programme, students will establish a strong foundation in mathematics, physics, thermodynamics, fluid mechanics, mechanics of solid and materials, electronics, programming, and engineering design and manufacture, enabling students to understand the fundamental principles of mechanical engineering. Level 5 of the programme builds on fundamental knowledge and skills acquired at Level 4, focusing on engineering principles underlying mechanical/automotive technologies. At Level 5, students will learn essential mathematical skills and knowledge required for analysing and solving equations, as well as handling complex data to improve efficiency and optimise processes. Workshops and laboratories such as the wind tunnel enhance students’ learning experiences through active learning techniques, encouraging students to develop curiosity and a desire to learn for life. In addition, students will be introduced to the principles and commercial practices for managing engineering projects and related business operations in the context of time, quality, risk and sustainability aspects, which provides insight into the legal, commercial, social and ethical framework of engineering environments.

Through team-based design activities and industrially-based projects, students will have ample opportunities to enhance their communication skills and develop their ability to work collaboratively. The Automotive Engineering pathway curriculum is designed to provide a comprehensive understanding of the design and analysis of automotive systems. It covers various topics such as the selection of materials and processes used in manufacturing automotive components and emerging electric, hybrid and alternative fuel vehicle technologies. The modules are structured to equip students with the skills and knowledge required to excel in the automotive industry.

At Level 6 of the programme, the mechanical/automotive theme is taken to the next level by placing a strong emphasis on the development of essential professional and leadership skills and management abilities in a collaborative group setting, where sustainability and ethics are woven into the fabric of the project, as well as fostering independent learning. The programme aims to build on the knowledge acquired in previous levels and provide a deeper understanding of mechanical/automotive engineering, covering topics such as the design and analysis of machine elements, fluid dynamics and microcontrollers. For students following the Automotive Engineering pathway, the programme also includes an exploration of high-performance vehicle aerodynamics.

By the end of Level 6, students should have acquired the skills and knowledge necessary to operate effectively in the professional world of mechanical/automotive engineering, as well as the ability to adapt to changing technologies and practices. The Individual Project module is a culmination of the technical and academic aspects of the programme, offering students a unique opportunity to apply the knowledge and skills they have acquired during the course in a capstone project. This module challenges students to achieve agreed deliverables, while honing their research skills and using technical literature to inform their work. Through this experience, students will gain valuable practical experience and demonstrate their ability to synthesise complex information and apply it to real-world problems.

At Level 7, students will have the opportunity to significantly expand their knowledge and skills. They will undertake a challenging team project, which involves project-based learning that is driven by the students themselves, while being supervised by academic staff who will encourage the development of professionalism and leadership within a collaborative setting. This project provides students with valuable experience in project planning, allowing them to put theory into practice by working on an industrial project. In addition to gaining practical skills, students will also learn about sustainability and ethics, which are integral parts of the project context.

A Personal Tutorial System is seamlessly incorporated into the curriculum, offering a structured platform for regular and discipline-specific small-group discussions and debates. Scheduled tutorial sessions are dedicated to reinforcing the core themes and practices of the programme, thereby enhancing the understanding and application of key concepts. These sessions serve as a valuable opportunity for students to deepen their knowledge, engage in thoughtful discussion, and clarify any uncertainties within the context of the curriculum.

***Research-informed teaching***

Most of the module teams are engaged in engineering research or industry-related professional activities, such as Knowledge Transfer Partnerships (KTPs), which have significantly influenced the design and content of the programme. The Department’s Industrial Advisory Board also provides valuable input from industry, further informing the programme’s development.

The academic staff are committed to continuous professional development in teaching and learning in higher education and wider pedagogic issues. Their research and development of innovative ideas informs the curriculum and enhances student learning experience both within and outside the classroom. As part of their pedagogic research, the staff has developed computing resources in fundamental subjects such as mathematics and mechanics, which are embedded in the Virtual Learning Environment (VLE) system. Furthermore, an electronic voting system has been adopted for summative and formative assessments, as an example of the staff’s commitment to pedagogic research. This reflective and evidence-based approach to teaching serves as a model for students to follow in their future professional practice.

***Interdisciplinary collaboration***

The Navigate for the Professional Engineer, Exploring Engineering Project Management and Applied Business Management modules are shared with students from various disciplines beyond mechanical and automotive engineering. This approach provides valuable experience for the students in working collaboratively across interdisciplinary teams, which is highly valued by many industries as an essential employability skill. The first year Navigate for the Professional Engineer module involves a team-based activity whereby the students are tasked to solve a design thinking challenge. In the second year Exploring Engineering Project Management module, students continue to develop their interdisciplinary teamwork skills and learn about team project management while working on a more complex challenge. Finally, in the third year Applied Business Management module, students consolidate their teamworking skills by undertaking a team-based design project within their own engineering discipline, building on the teamworking skills they have developed in earlier years.

***Hands-on practical work***

Hands-on practical experience in workshops and laboratories is crucial for developing practical skills and enhancing data collection and analysis abilities. Our curriculum includes practical work closely related to the theoretical content to provide context and reinforce learning. At Level 4, students learn basic measurement and manufacturing processes and apply them in laboratory and testing environments. At Level 5, the focus is on measuring a variety of parameters, with supervised practical sessions that follow experimental protocols. At Level 6, students are expected to select and apply requisite practical skills in their own independent research. At Level 7, our Mechanical Engineering students study specialised subjects such as machine learning, advanced stress analysis and electrification technologies in automotive industry, providing them with tools to solve more complex problems. Our Automotive Engineering students learn to analyse, research and design road vehicles. Both Mechanical Engineering and Automotive Engineering pathway students complete an extensive team project, applying their knowledge to a real-world and integrated industrially-based problem.

***Development of independent learning through the programme***

The learning, teaching and assessment strategy of the programme is designed to facilitate students’ progression in both curriculum content and skill development as they advance through the different levels of study. At Level 4, students receive comprehensive guidance and structured learning that focuses on acquiring essential engineering knowledge and skills (e.g., mathematics, programming, IT and practical skills) while also facilitating the development of key employability skills (e.g., transferrable skills). These provide a strong basis for students to undertake deeper study in a particular engineering field at Level 5. At this stage, students will be expected to engage in independent learning, with less emphasis on traditional lectures. As they progress to Level 6, students will assume greater responsibility for their independent study, while academic staff will play a supervisory role. This is particularly evident in the individual and team project modules.

The Module Guides provide clear expectations for students to engage in guided independent learning. At Level 4, students will be directed to utilise Technology Enhanced Learning (TEL) packages to prepare for individual topics or sessions, and to complete problem sets or exercises to consolidate and test their understanding. The VLE at Kingston offers a wide range of TEL resources, including videos, screencasts, online multiple-choice questions (MCQs), discussion boards and interactive teaching packages, to support learning throughout the programme. Additionally, the VLE delivers lecture notes/presentations, problem sets, and worked examples. This inclusive approach allows students to access learning material at their convenience, work through it at their own pace and have the flexibility to pause and rewind as needed.

***Assessment for learning***

The assessment tasks are designed to be authentic, engaging and transparent, focusing on real-world engineering activities that improve students’ employability. The programme employs a variety of assessment methods, including portfolios, quizzes, online tests, in-class tests, practical exercises, tutorial questions and end-of-module examinations. Additionally, all modules have explicit formative assessments to provide opportunities for practice and “feed forward” to help students improve their work for subsequent summative assessments. While examinations remain an effective way to assess basic knowledge and understanding, the strategy recognises that other assessment methods can also be well-suited to assess higher-level problem-solving skills. A well-balanced range of assessment methods is a key part of our inclusive assessment strategy, with group and teamwork assessment playing an instrumental role in developing and recognising this essential employability skill.

The programme employs various components to assess the modules including: practical exercises to evaluate students’ technical competence and understanding; individual and group-based project work to assess the ability to provide solutions to realistic problems, work effectively in a team, and communicate effectively through written reports, oral presentations or video. Multiple choice or short answer questions are also used to evaluate basic techniques and understanding of concepts, while long answer structured questions in coursework assignments and end-of-module examinations assess the ability to apply learned techniques and provide accurate solutions within a restricted time; the individual project module to assess the ability to plan work, manage time effectively and research background information, culminating in a written report and interview; and finally, individual and group laboratory reports are used to evaluate students’ technical competence and ability to work effectively in a laboratory setting.

***Inclusive teaching practice***

The University is committed to an inclusive curriculum, encouraging students to consider themselves as members of a professional community. The Student Voice Committee provides a platform for students to voice their opinions and suggest improvements for developing a more inclusive curriculum that takes into account the specific circumstances of the student body. To cater to different learning preferences and experiences, a diverse range of teaching activities is provided with a careful balance between individual and group-based activities. The assessment brief, provided at the beginning of the year, includes marking criteria for all assessments. The language used in the criteria is clear and concise to ensure that students understand the expectations. Additionally, in-class discussions are held to allow students to question and clarify any doubts regarding the marking criteria.

***Focus on active learning and enhancing student engagement***

The programme emphasises on active learning through collaborative, problem-solving and enquiry-based workshops and tutorials. Engaging sessions require students to prepare beforehand and actively participate during the class, as opposed to passively listening to lectures. Furthermore, the guided learning approach encourages students to consolidate their knowledge after the session. Additionally, students can benefit from opportunities for peer learning, group work and presentation practice. In these interactive sessions, the lecturer plays a crucial role in supporting students to construct their own knowledge and understanding while introducing and summarising key concepts through short mini lectures.

Active and collaborative learning techniques are utilised in the lectures, which may include interactive presentation software, question-and-answer sessions and brief student discussions integrated into the lecture. By incorporating these methods, valuable contact time is spent on applying and critically analysing knowledge, while also developing key skills such as problem-solving, communication and teamwork. To further promote student engagement and sense of belonging, the programme offers various opportunities for students to interact with staff and peers, including through the personal tutorial scheme (PTS), field work, industrial visits, extra-curricular seminars, research internships, course representative system, student ambassador work, peer mentoring and outreach initiatives, as well as hands-on activities such as IMechE Design Challenge, Formula Student, TT-Bike racing, and Robotics Club. These efforts also support improved retention and progression among students and enhance student engagement, creativity, confidence and self-reliance.

***Development of employability skills***

The programme not only focuses on imparting theoretical knowledge but also aims to develop a wide range of essential employability skills. This is achieved by embedding future-oriented skills throughout the curriculum via a personalised development programme called Navigate. Through the Navigate programme, students are equipped with effective communication, problem-solving and creative thinking skills – qualities that employers seek in graduates. The programme spans three years, with the first year being dedicated to understanding and reflection on the Kingston Graduate Attributes. The integration of ‘Skills for Innovation’ across both business and higher education domains ensures that graduates have the skills, experience and opportunities required to excel in their chosen careers.

Throughout all levels of the programme, students are encouraged to develop their research skills, which are a fundamental part of the curriculum. Through project work, they can collaborate with research-active staff on live projects. These experiences enable students to determine, distinguish and present appropriate evidence in an argument, which is highly valued by employers. Developing research skills is an essential component of the programme and will equip students with the necessary tools to conduct independent research and contribute to the field of mechanical/automotive engineering. By honing their research skills, students will be better equipped to solve complex problems, evaluate data and make informed decisions in their professional careers.

Employability criteria identified using feedback from employers, alumni, Industrial Advisory Board, and the Institution of Mechanical Engineers (IMechE) are embedded in the curriculum. Each module is examined to determine opportunities to incorporate employability skills. The University’s academic and Careers and Employability Service teams identify appropriate provisions and tailor opportunities to bridge gaps.

The IMechE Design Challenge, integrated into the course curriculum, fosters a pragmatic learning approach by challenging students to apply their acquired knowledge to practical and real-world engineering problems. From the conception to the construction and operation of a device within set technical parameters, students experience the full lifecycle of an engineering project. Not only does this develop technical competencies, but also cultivates valuable transferrable skills such as budgeting, public speaking and teamwork. It enables students to encounter and overcome challenges as they arise, instilling resilience, adaptability and innovation. Progressing through internal, regional and potentially national levels of the competition opens up numerous networking opportunities with potential employers and industry professionals.

The IMechE Formula Student competition, on the other hand, serves as an integral component of the curriculum, equipping students with a well-rounded skill set that extends beyond academic learning and prepares them for the demands of the professional world. Students are required to design and manufacture a prototype of a single-seat race car. This demanding task enables students to refine their technical skills and deepen their understanding of engineering design and manufacturing processes. Moreover, the competition goes beyond developing technical expertise. It provides a platform for students to cultivate essential skills like teamwork, time management, project management, budgeting, and presentation. These competencies, highly sought-after by employers, can significantly enhance students’ employability prospects.

To complement the development of employability skills in the curriculum, personal tutors enhance student engagement with employability opportunities by highlighting them within their sessions and encouraging students to participate in a variety of extracurricular activities. These activities may include student representation, part-time work, sports and recreation, society memberships, volunteering, student ambassadorship, leadership and mentoring, cultural and creative activities, academic and professional collaborations, placement opportunities, enterprise activities and events hosted by the University’s Careers and Employability Service. The University’s Kingston Award Scheme recognises participation in these areas.

Additionally, the Careers and Employability Service hosts a range of events, such as career fairs where employers promote internship, placement and graduate opportunities, as well as networking activities like spotlight on engineering, which invites employers and alumni to discuss career pathways on campus. Students develop a CPD record in the VLE to utilise for job applications and interviews.

For students pursuing the “with professional placement” degree on the sandwich route, the placement module (CI5999) is a crucial aspect of the programme. This module provides an extended opportunity to gain real-world employability skills in industry, making it a key element of the course. Moreover, the Careers and Employability Service offers support to students before and during their placement.

***Placement year***

Students are strongly encouraged to pursue an industrial placement either between Levels 5 and 6 or between Levels 6 and 7 as it offers a valuable opportunity to enhance both their academic knowledge and personal growth. Having two opportunities to go on a placement year offers students more flexibility in terms of when they choose to undertake a placement as some students prefer to gain work experience earlier in their degree, while others prefer to do so later. This flexibility enables students to tailor their learning experience to their individual needs and interests.

During the placement year, which lasts for at least 36 weeks and is conducted with an approved employer, students can apply their learning to practical situations that are relevant to their field of study. In addition to gaining work experience, students can reflect on their own personal development and evaluate the relationship between theory and practice. Students must maintain a comprehensive logbook documenting their activities and involvement in the company. At the end of their work period, students are expected to produce a final report that not only reflects on their experiences but also evaluates the organisational and business aspects of the company.

Students on courses with professional placement can register for the IMechE Monitored Professional Development Scheme (MPDS) scheme if they desire their placement year to be accredited by the IMechE. The MPDS scheme, adhering to the competencies outlined by the Engineering Council’s UK Standard for Professional Engineering Competence (UK-SPEC), provides the students with a structured development framework. This facilitates their journey towards professional registration by enabling them to demonstrate their learning through the submission of reports to the IMechE. Furthermore, participation in the MPDS scheme counts as the first year of industrial experience required for Chartership. Thus, the scheme not only aids students in their professional registration application but also acts as a catalyst for their career progression by speeding up their path towards Chartership.

Students will be supported throughout their placement by their placement tutor who will maintain contact with the students. During the placement, two visits from the placement tutor will take place to provide guidance and support. The primary objectives of these visits are to: support the student with the planning necessary to maximise success in their penultimate undergraduate year; encourage the student to reflect on the employability skills they have developed and be proactive in moving towards a professional life and/or further study; help the student to make best use of the feedback they have received so that they can build on their strengths and take steps to address any weaknesses.

The placement tutor will discuss the student’s progress with both the student, their employer and the student’s personal tutor (if different from their placement tutor) and recommend any necessary improvements to the learning opportunities. This approach ensures that students have a structured and supportive learning experience while gaining practical work experience in their field of study. The placement tutor’s involvement provides students with valuable guidance and feedback, while the logbook and final report encourage students to reflect on their learning and apply academic concepts to real-world situations.

Historically, many sandwich placements offer reasonable remuneration. While the University’s placement team provide support to students in securing a position, it is ultimately the student’s responsibility to secure their own placement, and placements are not guaranteed.

## Support for Students and their Learning

We are committed to helping our students succeed by providing tailored support and resources that meet their unique needs. Our personal tutor (PT) scheme plays a crucial role in delivering a personalised learning experience. For our Navigate for the Professional Engineer, Exploring Engineering Project Management and Applied Business Management modules at Levels 4, 5 and 6, respectively, we provide a core set of formative assessment problems that cover the curriculum. These problems enable students to test their learning and measure their progress. PTs use progress on these activities as a key discussion point during one-to-one meetings. To track their progress, students are required to upload their progress on these activities to their Learning Log, which is available to the relevant PTs. The PTs set milestones for students to meet at every level and monitor their progress, offering appropriate advice when needed. If students face difficulties, PTs can provide assistance or direct students to available support resources, such as peer mentoring schemes, Maths Aid and online resources. Students are supported by:

* A **Module Leader** for each module
* A **Course Leader** to help students understand their programme structure and provide academic support
* A **Personal Tutor** to provide academic advice and guidance
* An **Academic Team** that seeks to maintain an open-door policy in the spirit of supporting students
* A **Student Support and Engagement Team** to help students with any problem that is affecting their studies
* A dedicated **Course Administrator**
* An **Induction programme** and study skills sessions at the start of each academic year
* **Student Academic Success Centre (SASC)**, a one-to-one drop-in Study Skills session for students every weekday. Help is available on a range of academic skills from writing reports and note-taking to exam revision, referencing, programming and mathematical skills.
* **Virtual Learning Environment (VLE)**, a versatile on-line interactive intranet and learning environment accessible both on-site and remotely
* **Course Representative scheme**
* **University Careers** **and Employability Service**
* Comprehensive **University Support Systems** including the provision of advice on finance, regulations, legal matters, accommodation, international student support, disability and equality support
* The **Students’ Union**

***Personal Tutor Scheme (PTS)***

PT meetings provide an opportunity for students to discuss their personal and professional development, as well as career options. During these meetings, students receive individualised guidance and support tailored to their specific needs and goals. The following outlines the overall aims of the PTS in our School:

* To build a rapport between staff and students and contribute to personalising students’ experience within the School
* To support students in the development of their academic skills providing appropriate advice and guidance to students throughout their time at Kingston, while monitoring their progress, helping to identify individual needs and referring students to other University services as appropriate
* To help students develop the ability to be self-reliant and confident self-reflective learners who use feedback to their best advantage
* To encourage students to reflect on how their learning relates to a wider context and their personal career progression

PTs are allocated on a course basis during induction week. Student numbers are divided equally amongst the staff within the Department. Students will keep the same tutor throughout their course of study, except in cases where they change disciplines in their first year of study.

The PTS scheme is closely linked to the Navigate for the Professional Engineer, Exploring Engineering Project Management, and Applied Business Management modules, with specific aims and outcomes for each level. The scheme is progressive and cumulative, with students building on the skills developed in previous levels. Formative assessment is provided through regular feedback during meetings. Personal tutorials offer opportunities for students to develop CV writing skills, discuss their skill sets, learn and revise techniques, explore employment opportunities, and identify extracurricular activities that align with their interests and goals.

Group tutorials provide a forum for students to discuss issues and brainstorm solutions to problems. Attendance at personal tutorials is recorded by tutors using the Online Student Information System (OSIS). The PTS Lead oversees the scheme in the School in conjunction with the Faculty PTS Lead. Regular reports on student attendance in personal tutorials are consulted to identify and provide support for struggling students.

***Level 4: Settling in and building confidence***

At Level 4, we provide students with a comprehensive list of engagement activities that complement the core set of problems assigned for each module. PTs regularly discuss with their tutees’ progress on problem sets and participation in engagement activities throughout the academic year. PTs have access to the Learning Log, which facilitates further discussion during one-on-one meetings. To ensure that students stay on track, there are milestones to meet at every level, and PTs closely monitor their progress and provide relevant guidance and advice to help them succeed.

The aims of these activities are threefold: to assist students in making the transition to Higher Education and to generate a sense of belonging to the School and Department with an emphasis on widening participation issues; to help students to develop good academic habits and to gain the confidence to operate successfully in a university context; and to prepare students to make the most of feedback throughout their course.

The Navigate for the Professional Engineer module encourages students to engage in reflective practice and provides them with feedback on their progress towards acquiring essential skills. PT meetings will include discussions on these topics to ensure that students are adequately supported in their academic and professional development. PT meetings are scheduled throughout the academic year.

***Level 5: Stepping it up and broadening horizons***

At Level 5, students are expected to engage in reflection and evaluation of their skills acquisition and preparation for their industrial placement and future employment with the guidance of their PTs. This activity is integrated into the Explore module and aims to: help students comprehend and plan for the academic demands of Level 5 and to support increasing independence; encourage students to look forward, to take up opportunities to develop wider skills and to take responsibility for their personal development; foster students’ ability to build on and respond proactively to the feedback they have received; and assist students in reflecting on the skills that they are developing and consider how they relate to employability.

***Level 6: Maximising success and moving on***

PTs will have access to all formative and summative assessment results of their tutees and will be responsible for discussing them with the students. They will assist the students in preparing plans for further improvement and advise on any academic issues they may have. Additionally, PTs are responsible for providing a comprehensive overview of the learning, teaching, learning outcomes and assessments, linking them to the student’s progress.

## Ensuring and Enhancing the Quality of the Course

The University has several methods for evaluating and improving the quality and standards of its provision. These include:

* External examiners
* Education Committee with student representation
* Annual Monitoring and Enhancement
* Continuous Monitoring of courses through the Kingston Course Enhancement Programme (KCEP+)
* Student evaluation including Module Evaluation Questionnaires (MEQs), level surveys and the National Student Survey (NSS)
* Moderation policies
* Feedback from employers and alumni
* Industrial Advisory Board
* Professional body requirements

## Employability and work-based learning

Work placements are actively encouraged – although it is the responsibility of individual students to source and secure such placements. This allows students to reflect upon their own personal experience of working in an applied setting, to focus on aspects of this experience that they can clearly relate to theoretical concepts and to evaluate the relationship between theory and practice.

The Programme is designed to develop employability skills and prepare students to apply their knowledge and skills in real-world contexts. Throughout the curriculum, students will have opportunities to work in groups with external organisations at Level 4, gaining valuable experience to add to their CV when they apply for placements in Level 5. At the start of Level 5, students will be required to produce a CV, which they will then improve based on feedback. The Department strongly encourages and supports students in applying for an Industrial Placement year as the benefits of gaining approved industry experience are significant. Graduate destinations include Rolls-Royce, Lockheed Martin, British Aerospace, Atkins, McLaren, Jaguar Land-Rover, Ford, Williams F1, Vauxhall Alstom, Formula 1, British Airways and Subsea 7.

## Other sources of information that you may wish to consult

Engineering subject benchmark:

<https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements/subject-benchmark-statement-engineering>

Professional bodies:

[www.imeche.org](http://www.imeche.org)

Professional accreditation:

[www.engc.org.uk](http://www.engc.org.uk/)

[www.imeche.org](http://www.imeche.org/)

School Website:

[https://www.kingston.ac.uk/faculties/science-engineering-and-computing/about/schools/engineering](https://www.kingston.ac.uk/faculties/science-engineering-and-computing/about/schools/engineering/)

## Development of Course Learning Outcomes in Modules

The table presented below map where course learning outcomes are **summatively** assessed across the modules for the course. It provides an aid to academic staff in understanding how individual modules contribute to the course aims, a means to help students monitor their own learning, personal and professional development as the course progresses and a checklist for quality assurance purposes.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| MEng Mechanical EngineeringMEng Mechanical Engineering with Professional Placement – Students can undertake the placement either between Levels 5 and 6 or Levels 6 and 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Course Learning Outcomes** | | **Level 4 Modules** | | | | | | | | | | **Level 5 Modules** | | | | | | | | | | **Level 6 Modules** | | | | | | | | | **Level 7 Modules** | | | | | | | | |
| **ME4021** Navigate for the Professional Engineer | EG4017  Engineering Mathematics | | EG4016 Programming for Engineers | **EG4024** Thermodynamics and Fluid Mechanics | | **EG4019**Engineering Mechanics and Materials | | **EG4023**Engineering Design and  Manufacturing | **ME4222** Formula Student Fundamentals | **EG5016**Exploring Engineering Project Management | EG5015 Numerical Analysis and Computing | **ME5016** Solid Mechanics and Vibration | | **ME5015** Thermofluids | | **ME5017** Electronic and Control Systems | | **ME5018**Computer-Aided Engineering | | **EG6026**Applied Business Management | | **ME6017**Microcontrollers | | **ME6018**Fluid Dynamics and Thermal Systems | | EG6027 Dynamics and Control | **ME6019**Machine Design with Finite Element Method | **ME6020**Individual Project | **ME7019**  Electrification Technology in Automotive Industry | **ME7017**Additive Manufacturing | **ME7018**  Structural Integrity and Failure Analysis | **ME7016**Machine Learning | | **ME7020**Product Design Cycle Management | | **ME7021**  MEng Team Project | |
| **Knowledge and Understanding** | **A1** |  | **✓** | | **✓** | **✓** | | **✓** | | **✓** |  |  | **✓** | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** | |  | | **✓** | |
| **A2** |  |  | |  | **✓** | |  | | **✓** |  |  |  | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** | **✓** | |  | | **✓** | |
| **A3** |  |  | |  |  | | **✓** | |  |  |  |  | **✓** | |  | |  | |  | |  | |  | |  | |  | **✓** |  |  |  | **✓** |  | |  | |  | |
| **A4** |  |  | |  | **✓** | |  | |  |  |  |  |  | | **✓** | |  | |  | |  | |  | | **✓** | |  |  |  |  |  |  |  | |  | |  | |
| **A5** |  |  | |  |  | |  | | **✓** |  |  |  |  | |  | |  | | **✓** | |  | |  | |  | |  |  |  | **✓** | **✓** |  |  | |  | |  | |
| **A6** | **✓** |  | |  |  | |  | | **✓** |  | **✓** |  |  | |  | |  | | **✓** | | **✓** | |  | |  | |  |  |  |  |  |  |  | | **✓** | | **✓** | |
| **A7** |  |  | |  |  | |  | | **✓** | **✓** |  |  |  | |  | | **✓** | | **✓** | |  | | **✓** | | **✓** | |  |  |  | **✓** |  |  | **✓** | |  | | **✓** | |
| **Intellectual Skills** | **B1** |  |  | |  |  | |  | | **✓** |  |  |  |  | |  | |  | | **✓** | |  | |  | |  | |  | **✓** | **✓** |  |  | **✓** |  | |  | | **✓** | |
| **B2** |  | **✓** | |  |  | |  | |  |  |  | **✓** |  | |  | | **✓** | | **✓** | |  | |  | | **✓** | | **✓** | **✓** |  | **✓** | **✓** | **✓** | **✓** | |  | |  | |
| **B3** |  |  | |  |  | |  | |  |  |  |  | **✓** | |  | |  | |  | |  | |  | |  | |  | **✓** | **✓** |  |  |  |  | |  | | **✓** | |
| **B4** |  |  | |  |  | |  | | **✓** |  |  |  |  | |  | |  | | **✓** | |  | |  | |  | |  |  | **✓** |  |  |  |  | |  | | **✓** | |
| **B5** |  |  | |  |  | |  | | **✓** |  |  |  |  | |  | |  | | **✓** | |  | |  | |  | |  |  | **✓** |  |  |  |  | | **✓** | | **✓** | |
| **B6** |  |  | |  |  | |  | | **✓** |  |  |  |  | |  | |  | | **✓** | |  | |  | |  | |  |  | **✓** |  |  |  |  | | **✓** | | **✓** | |
| **B7** |  |  | |  |  | |  | | **✓** |  | **✓** |  |  | |  | |  | |  | | **✓** | |  | |  | |  |  |  |  |  |  |  | | **✓** | | **✓** | |
| **Subject Practical Skills** | **C1** |  |  | |  |  | | **✓** | | **✓** | **✓** |  |  |  | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | |  |  |  | **✓** | **✓** |  |  | |  | |  | |
| **C2** |  |  | |  |  | |  | | **✓** |  |  |  |  | |  | | **✓** | | **✓** | |  | | **✓** | |  | |  | **✓** |  |  |  |  |  | | **✓** | | **✓** | |
| **C3** |  |  | |  |  | | **✓** | |  |  |  |  |  | | **✓** | |  | |  | |  | |  | |  | |  |  |  |  | **✓** | **✓** |  | |  | |  | |
| **C4** |  |  | |  |  | |  | | **✓** | **✓** |  |  |  | |  | |  | | **✓** | |  | |  | |  | |  |  |  |  |  |  |  | |  | |  | |
| **C5** |  |  | |  |  | |  | | **✓** |  | **✓** |  |  | |  | |  | | **✓** | | **✓** | |  | |  | |  |  |  |  |  |  |  | |  | | **✓** | |
| **C6** |  |  | |  |  | |  | | **✓** |  |  |  |  | |  | |  | |  | |  | |  | |  | |  |  | **✓** |  |  |  |  | |  | | **✓** | |
| **C7** | **✓** |  | |  |  | |  | |  |  | **✓** |  |  | |  | |  | |  | | **✓** | |  | |  | |  |  |  |  |  |  |  | |  | | **✓** | |
| MEng Mechanical Engineering (Automotive Engineering)MEng Mechanical Engineering (Automotive Engineering) with Professional Placement – Students can undertake the placement either between Levels 5 and 6 or Levels 6 and 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Course Learning Outcomes** | | **Level 4 Modules** | | | | | | | | | | **Level 5 Modules** | | | | | | | | | | **Level 6 Modules** | | | | | | | | | **Level 7 Modules** | | | | | | | | |
| **ME4021** Navigate for the Professional Engineer | EG6017 Engineering Mathematics | EG4016 Programming for Engineers | | | **EG4024**Thermodynamics and Fluid Mechanics | **EG4019**Engineering Mechanics and Materials | **EG4023**Engineering Design and  Manufacturing | | **ME4222** Formula Student Fundamentals | **EG5016**Exploring Engineering Project Management | EG5015Numerical Analysis and Computing | | **ME5019**Vehicle Dynamics and Suspension | | **ME5020** Automotive Powertrain Systems | | **ME5017**Electronic and Control Systems | | ME6023 Automotive Design Team Project | **EG6026** Applied Business Management | **ME6017** Microcontrollers | | **ME6022**High Performance Vehicle Aerodynamics | | **ME6023**Automotive Design and Structural Analysis | | **ME6019**Machine Design with Finite Element Method | **ME66020** Individual Project | **ME77022**Automotive Aerodynamics and Structural Analysis | **ME7023** Advanced Control Systems | **ME77024** Engineering and Business Resource Management | | **ME7019** Electrification Technology in Automotive Industry | | **ME77020**Product Design Cycle Management | | **ME77021** MEng Team Project |
| **Knowledge and Understanding** | **A1** |  | **✓** | **✓** | | | **✓** | **✓** | **✓** | |  |  | **✓** | | **✓** | | **✓** | | **✓** | | **✓** |  | **✓** | | **✓** | | **✓** | | **✓** | **✓** | **✓** | **✓** |  | | **✓** | |  | | **✓** |
| **A2** |  |  |  | | | **✓** |  | **✓** | |  |  |  | | **✓** | | **✓** | | **✓** | | **✓** |  | **✓** | | **✓** | | **✓** | | **✓** | **✓** | **✓** | **✓** |  | | **✓** | |  | | **✓** |
| **A3** |  |  |  | | |  | **✓** |  | |  |  |  | | **✓** | |  | |  | |  |  |  | |  | | **✓** | | **✓** |  |  |  |  | |  | |  | |  |
| **A4** |  |  |  | | | **✓** |  |  | |  |  |  | |  | | **✓** | |  | |  |  |  | | **✓** | |  | |  |  | **✓** |  |  | |  | |  | |  |
| **A5** |  |  |  | | |  |  | **✓** | |  |  |  | |  | |  | |  | | **✓** |  |  | |  | |  | |  |  |  |  |  | | **✓** | |  | |  |
| **A6** | **✓** |  |  | | |  |  | **✓** | |  | **✓** |  | |  | |  | |  | | **✓** | **✓** |  | |  | |  | |  |  |  |  |  | |  | | **✓** | | **✓** |
| **A7** |  |  |  | | |  |  | **✓** | | **✓** |  |  | |  | | **✓** | | **✓** | | **✓** |  | **✓** | | **✓** | |  | |  |  |  | **✓** |  | | **✓** | |  | | **✓** |
| **Intellectual Skills** | **B1** |  |  |  | | |  |  | **✓** | |  |  |  | |  | |  | |  | | **✓** |  |  | |  | |  | | **✓** | **✓** |  | **✓** |  | |  | |  | | **✓** |
| **B2** |  | **✓** |  | | |  |  |  | |  |  | **✓** | | **✓** | | **✓** | | **✓** | | **✓** |  |  | | **✓** | | **✓** | | **✓** |  | **✓** | **✓** |  | | **✓** | |  | |  |
| **B3** |  |  |  | | |  |  |  | |  |  |  | |  | |  | |  | |  |  |  | | **✓** | | **✓** | | **✓** | **✓** |  |  |  | |  | |  | | **✓** |
| **B4** |  |  |  | | |  |  | **✓** | |  |  |  | |  | |  | |  | | **✓** |  |  | |  | |  | |  | **✓** |  |  |  | |  | |  | | **✓** |
| **B5** |  |  |  | | |  |  | **✓** | |  |  |  | |  | |  | |  | | **✓** |  |  | |  | |  | |  | **✓** |  |  | **✓** | |  | | **✓** | | **✓** |
| **B6** |  |  |  | | |  |  | **✓** | |  |  |  | |  | |  | |  | | **✓** |  |  | |  | |  | |  | **✓** |  |  | **✓** | |  | | **✓** | | **✓** |
| **B7** |  |  |  | | |  |  | **✓** | |  | **✓** |  | |  | |  | |  | |  | **✓** |  | |  | |  | |  |  |  |  | **✓** | |  | | **✓** | | **✓** |
| **Subject Practical Skills** | **C1** |  |  |  | | |  | **✓** | **✓** | | **✓** |  |  | | **✓** | | **✓** | | **✓** | | **✓** |  | **✓** | | **✓** | | **✓** | |  |  | **✓** |  |  | | **✓** | |  | |  |
| **C2** |  |  |  | | |  |  | **✓** | |  |  |  | |  | |  | | **✓** | | **✓** |  | **✓** | |  | |  | | **✓** |  |  |  |  | |  | | **✓** | | **✓** |
| **C3** |  |  |  | | |  | **✓** |  | |  |  |  | | **✓** | | **✓** | |  | |  |  |  | | **✓** | | **✓** | |  |  |  |  |  | |  | |  | |  |
| **C4** |  |  |  | | |  |  | **✓** | | **✓** |  |  | |  | |  | |  | | **✓** |  |  | |  | |  | |  |  |  |  |  | |  | |  | |  |
| **C5** |  |  |  | | |  |  | **✓** | |  | **✓** |  | |  | |  | |  | | **✓** | **✓** |  | |  | |  | |  |  |  |  |  | |  | |  | | **✓** |
| **C6** |  |  |  | | |  |  | **✓** | |  |  |  | |  | |  | |  | |  |  |  | |  | |  | |  | **✓** |  |  |  | |  | |  | | **✓** |
| **C7** | **✓** |  |  | | |  |  |  | |  | **✓** |  | |  | |  | |  | |  | **✓** |  | |  | |  | |  |  |  |  |  | |  | |  | | **✓** |

## APPENDIX

## PSRB Learning Outcomes Mapping – IMechE AHEP4

**M1.** Apply a comprehensive knowledge of mathematics, statistics, natural science and engineering principles to the solution of complex problems. Much of the knowledge will be at the forefront of the particular subject of study and informed by a critical awareness of new developments and the wider context of engineering.

**M2.** Formulate and analyse complex problems to reach substantiated conclusions. This will involve evaluating available data using first principles of mathematics, statistics, natural science and engineering principles, and using engineering judgment to work with information that may be uncertain or incomplete, discussing the limitations of the techniques employed.

**M3.** Select and apply appropriate computational and analytical techniques to model complex problems, discussing the limitations of the techniques employed.

**M4.** Select and critically evaluate technical literature and other sources of information to solve complex problems.

**M5.** Design solutions for complex problems that evidence some originality and meet a combination of societal, user, business and customer needs as appropriate. This will involve consideration of applicable health & safety, diversity, inclusion, cultural, societal, environmental and commercial matters, codes of practice and industry standards.

**M6.** Apply an integrated or systems approach to the solution of complex problems.

**M7.** Evaluate the environmental and societal impact of solutions to complex problems (to include the entire life-cycle of a product or process) and minimise adverse impacts.

**M8.** Identify and analyse ethical concerns and make reasoned ethical choices informed by professional codes of conduct.

**M9.** Use a risk management process to identify, evaluate and mitigate risks (the effects of uncertainty) associated with a particular project or activity.

**M10.** Adopt a holistic and proportionate approach to the mitigation of security risks.

**M11.** Adopt an inclusive approach to engineering practice and recognise the responsibilities, benefits and importance of supporting equality, diversity and inclusion.

**M12.** Use practical laboratory and workshop skills to investigate complex problems.

**M13.** Select and apply appropriate materials, equipment, engineering technologies and processes, recognising their limitations.

**M14.** Discuss the role of quality management systems and continuous improvement in the context of complex problems.

**M15.** Apply knowledge of engineering management principles, commercial context, project and change management, and relevant legal matters including intellectual property rights.

**M16.** Function effectively as an individual, and as a member or leader of a team. Evaluate effectiveness of own and team performance.

**M17.** Communicate effectively on complex engineering matters with technical and non-technical audiences, evaluating the effectiveness of the methods used.

**M18.** Plan and record self-learning and development as the foundation for lifelong learning/CPD.

The tables below indicate which modules assume responsibility for delivering (shaded) and assessing (**✓**) particular IMechE AHEP4 learning outcomes in the courses mentioned at the top row of the tables:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MEng Mechanical EngineeringMEng Mechanical Engineering with Professional Placement – Students can undertake the placement either between Levels 5 and 6 or Levels 6 and 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **IMechE AHEP4 Learning Outcomes** | **Level 4 Modules** | | | | | | | | | | | **Level 5 Modules** | | | | | | | | | | | | **Level 6 Modules** | | | | | | | | | | | | **Level 7 Modules** | | | | | | | | |
| ME4021 Navigate for the Professional Engineer | | EG4017 Engineering Mathematics | EG4016Programming for Engineers | | **EG4024** Thermodynamics and Fluid Mechanics | | **EG4019**Engineering Mechanics and Materials | | **EG4023** Engineering Design and Manufacture | | **EG5016**Exploring Engineering Project Management | | EG5015 Numerical Analysis and Computing | | **ME5016**  Solid Mechanics and Vibration | | **ME5015** Thermofluids | | **ME5017**Electronic and Control Systems | | **ME5018**Computer-Aided  Engineering | | **EG6026** Applied Business Management | | **ME6017** Microcontrollers | | **ME6018**Fluid Dynamics and Thermal Systems | | EG6027 Dynamics and Control | | **ME6019** Machine Design with Finite Element Method | | **ME6020** Individual Project | | **ME77019** Electrification Technology in Automotive Industry | | **ME7017** Additive Manufacturing | | **ME7018**Structural Integrity and Failure Analysis | | **ME7016** Machine Learning | **ME7020**Product Design Cycle Management | **ME7021** MEng Team Project |
| **M1** |  | | **✓** | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** |  | **✓** |
| **M2** |  | |  |  | | **✓** | |  | | **✓** | |  | |  | | **✓** | | **✓** | | **✓** | |  | |  | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** |  | **✓** |
| **M3** |  | | **✓** | **✓** | |  | |  | |  | |  | | **✓** | |  | |  | | **✓** | | **✓** | |  | |  | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | | **✓** |  |  |
| **M4** |  | |  |  | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  |  | **✓** |
| **M5** |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  |  | **✓** |
| **M6** |  | |  |  | |  | |  | |  | |  | |  | |  | |  | | **✓** | | **✓** | |  | | **✓** | |  | | **✓** | |  | |  | | **✓** | | **✓** | | **✓** | | **✓** |  | **✓** |
| **M7** | **✓** | |  |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | **✓** | **✓** |
| **M8** |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | **✓** | **✓** |
| **M9** |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | **✓** | **✓** |
| **M10** | **✓** | |  |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | **✓** |
| **M11** |  | |  |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | **✓** | **✓** |
| **M12** |  | |  |  | |  | | **✓** | | **✓** | |  | |  | |  | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | |  | |  | |  | | **✓** | | **✓** | |  | |  |  |  |
| **M13** |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | | **✓** | |  | |  | | **✓** | |  | |  | |  | |  | |  | **✓** | **✓** |
| **M14** |  | |  |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | **✓** | **✓** |
| **M15** |  | |  |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | **✓** | **✓** |
| **M16** |  | |  |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | **✓** |
| **M17** |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  |  | **✓** |
| **M18** | **✓** | |  |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |  |
| MEng Mechanical Engineering (Automotive Engineering)MEng Mechanical Engineering (Automotive Engineering) with Professional Placement – Students can undertake the placement either between Levels 5 and 6 or Levels 6 and 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **IMechE AHEP4 Learning Outcomes** | **Level 4 Modules** | | | | | | | | | | **Level 5 Modules** | | | | | | | | | | | | **Level 6 Modules** | | | | | | | | | | | | **Level 7 Modules** | | | | | | | | | |
| ME4021 Navigate for the Professional Engineer | **M** EG4017 Engineering Mathematics | | EG4016 Programming for Engineers | **EG4024**Thermodynamics and Fluid Mechanics | | **EG4019** Engineering Mechanics and Materials | | **ME44016** Engineering Design and Manufacture | | **EG5016**Exploring Engineering Project Management | | EG5015Numerical Analysis and  Computing | | **ME5019**Vehicle Dynamics and Suspension | | **ME55020**Automotive Powertrain Systems | | **ME5017**Electronic and Control Systems | | **ME5022**Automotive Design Team Project | | **EG6026** Applied Business Management | | **ME6017** Microcontrollers | | **ME6022**High Performance Vehicle Aerodynamics | | **ME6023** Automotive Design and Structural Analysis | | **ME6019**Machine Design with Finite Element Method | | **ME6020** Individual Project | | **ME7022**Automotive Aerodynamics and Structural Analysis | | **ME7023** Advanced Control Systems | | **ME7024** Engineering and Business Resource Management | | **ME7019** Electrification Technology in Automotive Industry | | **ME7020**Product Design Cycle Management | **ME7021** MEng Team Project |
| **M1** |  | **✓** | | **✓** | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | |  | **✓** |
| **M2** |  |  | |  | **✓** | |  | | **✓** | |  | |  | | **✓** | |  | | **✓** | |  | |  | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | |  | **✓** |
| **M3** |  | **✓** | | **✓** |  | |  | |  | |  | | **✓** | | **✓** | | **✓** | | **✓** | | **✓** | |  | |  | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | |  | | **✓** | |  |  |
| **M4** |  |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | **✓** | | **✓** | | **✓** | | **✓** | |  | |  | |  | |  | |  | **✓** |
| **M5** |  |  | |  |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | **✓** |
| **M6** |  |  | |  |  | |  | |  | |  | |  | |  | |  | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | |  | |  | |  | | **✓** | |  | | **✓** | |  | **✓** |
| **M7** | **✓** |  | |  |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | |  | |  | | **✓** | |  | | **✓** | **✓** |
| **M8** |  |  | |  |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | | **✓** | |  | | **✓** | **✓** |
| **M9** |  |  | |  |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | | **✓** | |  | | **✓** | **✓** |
| **M10** | **✓** |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | **✓** |
| **M11** |  |  | |  |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | | **✓** | |  | | **✓** | **✓** |
| **M12** |  |  | |  |  | | **✓** | | **✓** | |  | |  | | **✓** | | **✓** | | **✓** | | **✓** | |  | | **✓** | | **✓** | | **✓** | |  | |  | | **✓** | |  | |  | | **✓** | |  |  |
| **M13** |  |  | |  |  | |  | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | | **✓** | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | **✓** |
| **M14** |  |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | |  | |  | | **✓** | |  | | **✓** | **✓** |
| **M15** |  |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | | **✓** | |  | |  | | **✓** | |  | | **✓** | **✓** |
| **M16** |  |  | |  |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | | **✓** | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | **✓** |
| **M17** |  |  | |  |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | **✓** |
| **M18** | **✓** |  | |  |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | | **✓** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |