Standard
L6: Space systems engineer

**UOS reference number**
ST0856_V0.0

**Title of occupation**
Space systems engineer

**Core and options**
No

**Resubmission**
No

**Level of occupation**
Level 6

**Route**
Engineering and manufacturing

**Typical duration of apprenticeship**
48 months

**Target date for approval**
31 January 2022

**Occupational profile**

**Summary**
This occupation is found in the space sector, and primarily the "upstream" manufacturing area. This covers the design and production of spacecraft and the components and subsystems they comprise, along with production, operation and maintenance of highly specialised ground support equipment. Ground support equipment is used to support the development and testing of satellites and other equipment flown in space, before launch. The upstream element of the industry is part of the overall space sector. It is related to but distinct from the "downstream" part of the sector. The downstream sector is concerned with the exploitation of data from satellites for end-user applications including weather forecasting and telecommunications. Although businesses in the downstream sector work mainly with data and services, many also employ space systems engineers. Income for the whole UK space sector has grown significantly. The upstream segment has been the majority contributor to the overall growth of the sector. Space is a key part of the UK's Industrial Strategy supporting the development and increases in productivity of other key sectors. For example, Agribusiness, Transport and Health, through improved data provision and communications. Government has committed funding to new developments supporting the upstream sector. Investments include establishing UK space ports, funding of spacecraft technology programmes and a satellite launch capability, and the National Satellite Test Facility.

The broad purpose of the occupation is to take a leading role in the design, manufacturing and testing of complex, high value space hardware and ground support equipment at component and sub-system level, using advanced integration skills. Space Systems Engineers receive customer and mission requirements. They use engineering and scientific principles and knowledge of the space environment to identify solutions to requirements. They also assist in research and development, provide technical expertise, support, solutions and leadership. They work with other engineering functions within dedicated spacecraft and space equipment programmes, for customer applications and research and technology development projects.

Space Systems Engineers typically work in secure and controlled environments, workshops and development areas (including working at ground level, and at high level on gantries and walkways) as well as in regular offices. Some of these environments can be highly specialised (for example, rocket propulsion test facilities) and can involve working with very high pressure gas and fluid delivery systems, high vacuum facilities, and cryogenic fluids and delivery systems.

Space Systems Engineers work in a variety of businesses. These can be small to medium enterprises. For example, specialising in, or involved with, space systems and space technology. They can also work in large national or global aerospace companies and space agencies. They are also found in academic institutions. Institutions include universities, government-funded science and technology research and development laboratories. Space Systems Engineers typically work to normal business hours. However, they can be required to work shifts and weekends in particular circumstances. For example, during launch support, or in periods leading up to major project delivery milestones.

An employee in this occupation is responsible for the quality and accuracy of the work they undertake within the limits of their personal authority. Space systems engineers adhere to statutory regulations and organisational health and safety requirements. They also identify, and carry out work in compliance with, standards imposed by key customers. For example, space agencies and regulatory bodies such as the International Organization for Standardization (ISO) or the European Cooperation for Space Standardization (ECSS).

**Typical job titles**
['Advanced manufacturing engineer', 'Assembly integration and test manager', 'Attitude and orbit control system (aocs) engineer', 'Control and instrumentation engineer', 'Electrical and electronic engineer', 'Materials engineer', 'Payload systems engineer', 'Product and quality assurance engineer', 'Satellite manufacturing assembly integration and test (ait) engineer', 'Spacecraft mechanical engineer', 'Spacecraft power systems engineer', 'Spacecraft propulsion engineer', 'Spacecraft systems engineer', 'Thermal design engineer']
Duties

**Duty**

D1: Identify and define requirements, architecture, design and verification methodologies for spacecraft subsystems. For example, power, propulsion, attitude control, communications or thermal control.

D2: Select techniques, components and materials appropriate for application in the mission environment. For example, vacuum-compatible materials, or electronics components that can withstand radiation.

D3: Provide engineering support for mission-specific and research and development projects. For example, providing inputs on vibration test levels and interpreting other test performance data for project teams.

D4: Provide systems-specific expertise during launch and early operations phases of a mission.

D5: Provide technical expertise and team leadership in support of integration and testing at subsystem, spacecraft and ground level across a range of projects.

D6: Perform system level trade-offs, co-ordinating inputs from various disciplines within a team to evaluate optimal solutions or proposed changes to a design. For example, calculating the antenna size required for two different designs of spacecraft communication systems to reach a recommendation for the optimal design, or estimating the change in power availability when changing the design of solar array.

D7: Provide technical expertise and support to the project system engineer by contributing to requirements management, ensuring all requirements are closed-out at the relevant project reviews and milestones. Contribute to technology readiness level for component/sub-system maturity status on space programmes.

D8: Define test plans and procedures and compile test reports, managing test data and results for development and verification of the subsystem and spacecraft design.

D9: Manage technical and project documentation used for control, monitoring, verification and reporting during a space project.

D10: Provide engineering expertise to the project manager and lead systems engineer to assist in the formulation of risk assessments, project budgets and schedules.

D11: Provide oversight of resource budgets and margins within the project. For example, mass, power and volume of a design.

**Knowledge**

- K1, K2, K3, K5, K6, K7, K8, K10, K11, K12, K21, K22, K23, K24, K26, K29
- K6, K7, K12, K13, K14, K22, K23, K29
- K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13, K14, K15, K16, K17, K20, K21, K23, K24, K26, K28, K29
- K1, K2, K3, K4, K21, K23, K30
- K2, K12, K14, K15, K16, K17, K20, K22, K24, K25, K26, K27, K28
- K5, K13, K15, K16, K18, K19, K20, K28
- K14, K15, K16, K17, K18, K19, K20, K21, K24, K25
- K13, K15, K16, K17, K18, K19, K20, K21, K28
- K18, K19, K20, K25
- K19, K20

**Skills**

- S1, S4, S8, S9, S10, S13, S14
- S1, S8, S9, S10, S13, S14
- S2, S4, S6, S7, S8, S9, S10, S14
- S3, S10, S14
- S2, S3, S4, S5, S7, S10, S14, S15, S16
- S1, S3, S4, S7, S8, S9, S10, S13, S14
- S2, S3, S4, S7, S10, S14
- S2, S3, S4, S7, S10, S14
- S7, S12, S14, S15
- S3, S4, S7, S10, S12, S14, S17

**Behaviours**

- B1, B2, B3, B4, B5, B6, B7
- B1, B2, B3, B4, B5, B6, B7
- B1, B2, B3, B4, B5, B6, B7
- B1, B2, B3, B4, B5, B6, B7
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## Duties (continued)

<table>
<thead>
<tr>
<th>Duty</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Behaviours</th>
</tr>
</thead>
<tbody>
<tr>
<td>D12: Identify solutions for technical designs, techniques and processes relevant to a project using appropriate engineering disciplines and techniques. For example, identifying test standards and test procedures for new designs, new materials and new manufacturing processes for specific applications, or bonding techniques for assemblies involving novel combinations of materials.</td>
<td>K1, K2, K5, K6, K7, K8, K9, K10, K11, K12, K13, K14, K15, K16, K17, K20, K22, K23, K24, K26</td>
<td>S1, S4, S8, S9, S10, S11, S12, S13, S14</td>
<td>B1, B2, B3, B4, B5, B6, B7</td>
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<td>D13: Lead technical teams within a project, including line-management of technical staff working within a team.</td>
<td>K19, K25, K27, K28</td>
<td>S2, S3, S5, S14, S15, S16, S17</td>
<td>B1, B2, B3, B4, B5, B6, B7</td>
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<td>D14: Contribute to overall project management by coordinating the allocation of technical staff within a team and working with the project manager and lead systems engineer to ensure delivery of the project on-time and within budget.</td>
<td>K15, K18, K19, K25, K26, K27, K28</td>
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<td>B1, B2, B3, B4, B5, B6, B7</td>
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Knowledge, skills and behaviours

Knowledge
K1: Spacecraft Dynamics and Control Techniques: two-body orbital motion and perturbations, sources of disturbance, spacecraft attitude control, manoeuvres, station keeping and rendezvous operations.
K2: Architecture of ground and space-based communications subsystems.
K3: Mission Concept of Operations: mission phasing, operational scenarios and modes, timelines, ground and space segments, communications and data handling architecture.
K4: The role of the ground station in mission operations.
K5: Principles of electric or chemical propulsion systems.
K6: Structural analysis for static and dynamic loads.
K7: Design, analysis and operation of thermal control systems.
K8: Application of Finite Element Analysis and system modelling software for mechanical, electrical and electromechanical sub-systems.
K10: Practical and theoretical requirements of electrical, electronic, electromechanical and mechanical equipment and systems in the space context.
K11: Design of mechanisms and deployable structures in a space context.
K12: The space environment: vacuum, thermal, radiation, particulate, atmospheres, vibration and thermal environment during launch.
K13: Purpose of approved processes, components, parts and materials lists.
K14: Properties, handling and application of space qualified materials.
K15: Principles of Quality Assurance and quality standards in space projects.
K16: Test standards in the space context.
K17: Principles, processes and techniques for thermal-vacuum, electromagnetic compatibility, shock, vibration and acoustic testing, reporting and post-test procedures and actions.
K19: Principles of Project Management in space projects.
K21: Life cycles of Space instrumentation for near Earth and Deep Space missions.
K22: Techniques and strategies used for the manufacture and fabrication of Space hardware, and impact of manufacturing processes on material properties.
K23: The upstream space sector, its applications, and the typical characteristics of spacecraft used in different mission types.
K24: The role of software in the function and control of spacecraft and ground facilities.
K25: Legal requirements: Health and Safety at Work, Environmental Protection and Sustainability, General Data Protection Regulation, Space Industry Act (Background, Range control, Licences, Safety, Security, Liabilities, Indemnities and Insurance).
K27: Teamwork and leadership: negotiation techniques, conflict management, mentoring and development techniques, diversity, equality and inclusivity considerations.
K28: Communication and presentation techniques: verbal and written.
K29: Engineering Drawing principles: development drawings, qualification drawings and production drawings using Computer Aided Design (CAD) software for creating 3D models and 2D drawings including schematics and circuit diagrams.
K30: Events and activities in the launch and commissioning phases of a mission, for example monitoring diagnostic information from the spacecraft before launch, or interpreting performance data during commissioning phase of the mission.

Skills
S1: Identify and implement technical engineering solutions. For example, by using trade studies.
S2: Communicate with colleagues and stakeholders: verbal and written.
S3: Present information. For example, presenting project progress and key performance information (KPI’s) such as cost, quality, time, risk and opportunities, contributing to technical publications, conveying information to technical and non-technical audiences.
S4: Review and interpret customer requirements for the function and performance of their spacecraft or subsystem.
S5: Produce space engineering designs, specifications and drawings. For example, for tender and manufacturing stages.
S6: Contribute to the preparation of technical proposals. For example by providing the lead engineer with technical input.
S7: Contribute to technical reviews with stakeholders. For example explaining proposed solutions to the customer.
S8: Perform design and mechanical-structural, thermal and dynamic-vibration analysis, for deployable structures.
S9: Calculate and model the performance of electronic, mechanical and thermal subsystems using approved industry techniques. For example, communications, power, data handling and thermal control.
S10: Use scientific and engineering data. For example, to support decision making during design, build and operations phases of a mission or project.
S11: Identify and apply test standards and procedures. For example, identify and apply test standards for a specific project or mission.
S12: Prepare and apply technical documentation. For example, schedules, test plans, test reports, quality reports, and the digital tools used for their preparation.
S13: Research technical solutions to problems. For example, use peer-reviewed literature and technical publications to research technical solutions with awareness of patent rules.

Date generated: 17 March 2022
S14: Use information technology including digital tools for presentation of data, digital communication, collaboration, design and analysis.
S15: Identify and comply with legal and statutory requirements. For example, health and safety, Environmental protection, sustainability, space certification requirements and data protection.
S16: Work with and lead others including, negotiation, conflict management, mentoring and developing others; taking account of diversity, equality and inclusivity
S17: Mission Analysis techniques using numerical analysis and simulation tools such as AGI-Systems Toolkit or NASA-GMAT.

Behaviours
B1: Act as a role model and advocate for the environment, and sustainability.
B2: Collaborate and promote teamwork across disciplines.
B3: Apply a professional approach
B4: Adapt to, and resilient in challenging or changing situation.
B5: Commits to their own and supports others’ professional development.
B6: Act as an advocate for accessibility, diversity, and inclusion.
B7: Act as a role model and advocate for health and safety.
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### Qualifications

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<tr>
<td>A space engineering or space science degree or other space degree that fully aligns to the KSBs Hard sift on the apprenticeship</td>
<td>Level: 6 (integrated degree)</td>
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<tr>
<td></td>
<td>Type: Type 1 Qualification that accredits occupational competence</td>
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<tr>
<td></td>
<td>Ofqual regulated: No</td>
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<tr>
<td>Awarding bodies</td>
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<tr>
<td>• University of Leicester</td>
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<tr>
<td>• University of Western England</td>
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<tr>
<td>• University of Bath</td>
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Entry requirements

Individual employers will set the selection criteria for their space systems engineer apprentices. Typically, candidates will have achieved grade 4 (previously grade C) or above in at least five GCSE’s including English, Maths and a Science subject. Employers will set their own entry requirements but typically candidates will hold a minimum of 96 UCAS points or existing relevant Level 3 qualifications. Other relevant or prior experience may also be considered as an alternative.

This standard represents a logical progression for candidates who have completed lower level apprenticeships in the Engineering And Manufacturing pathways, for example: Engineering Fitter (L3), Engineering Technician (L3), Engineering Manufacturing Technician (L4), Space Engineering Technician (L4), Maintenance Operations Engineering Technician (L3).

T Level and A Level qualifications in Science and Engineering subject areas, and Level 3 qualifications (such as BTEC, City & Guilds or Cambridge Technicals), in science and engineering also offer routes into this apprenticeship.

Professional recognition

<table>
<thead>
<tr>
<th>Professional body</th>
<th>Level</th>
<th>Full or partial recognition</th>
<th>What further requirements are needed for full recognition</th>
</tr>
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<tbody>
<tr>
<td>The Institute of Engineering &amp; Technology (IET)</td>
<td>Incorporated Engineer (IEng)</td>
<td>Partial</td>
<td>Some additional experience in project management may be required to meet the full requirements for professional recognition.</td>
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<td>Royal Aeronautical Society</td>
<td>Incorporated Engineer (IEng)</td>
<td>Partial</td>
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Progression routes

ST0010: L6: Aerospace engineer (degree)
ST0013: L6: Aerospace software development engineer (degree)
ST0107: L7: Systems engineer (degree)
ST0456: L7: Post graduate engineer