# Management Science and Engineering Undergraduate Major

See the "Department of Management Science and Engineering (http://exploredegrees.stanford.edu/schoolofengineering/managementscienceandengineering)" section of this bulletin for additional information on the department, and its programs and faculty.

The department offers a B.S. as well as a minor in Management Science and Engineering.

## Management Science and Engineering (MS&E)

Completion of the undergraduate program in Management Science and Engineering leads to the conferral of the Bachelor of Science in Management Science and Engineering.

### Requirements

<table>
<thead>
<tr>
<th>Units</th>
<th>Mathematics and Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>Up to ten units of AP/IB Calculus, MATH 19, 20, 21, 41, or 42. ¹</td>
</tr>
<tr>
<td>10</td>
<td>All required; see SoE Basic Requirements 1 and 2</td>
</tr>
<tr>
<td>23</td>
<td>CME 100 or MATH 51 Vector Calculus for Engineers Lineal Algebra, Multivariable Calculus, and Modern Applications</td>
</tr>
<tr>
<td></td>
<td>CME 103 Introduction to Matrix Methods</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 120 Probabilistic Analysis</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 121 Introduction to Stochastic Modeling</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 125 Introduction to Applied Statistics</td>
</tr>
<tr>
<td>8</td>
<td>Select two of the following: ²</td>
</tr>
<tr>
<td></td>
<td>CHEM 31B Chemical Principles II</td>
</tr>
<tr>
<td></td>
<td>CHEM 33 Structure and Reactivity of Organic Molecules</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 41 Mechanics</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 21 Mechanics, Fluids, and Heat</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 43 Electricity and Magnetism</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 23 Electricity, Magnetism, and Optics</td>
</tr>
<tr>
<td></td>
<td>BIO 81 Introduction to Ecology</td>
</tr>
<tr>
<td></td>
<td>BIO 82 Genetics</td>
</tr>
<tr>
<td></td>
<td>BIO 83 Biochemistry &amp; Molecular Biology</td>
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<tr>
<td></td>
<td>BIO 84 Physiology</td>
</tr>
<tr>
<td></td>
<td>BIO 85 Evolution</td>
</tr>
<tr>
<td></td>
<td>BIO 86 Cell Biology</td>
</tr>
<tr>
<td></td>
<td>Math, Science, or Statistics Elective from SoE approved lists. ³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Technology in Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>AA 252 Techniques of Failure Analysis</td>
</tr>
<tr>
<td></td>
<td>COMM 120W The Rise of Digital Culture</td>
</tr>
<tr>
<td></td>
<td>BIOE 131 Ethics in Bioengineering</td>
</tr>
<tr>
<td></td>
<td>CS 181 Computers, Ethics, and Public Policy</td>
</tr>
<tr>
<td></td>
<td>ENGR 117 Expanding Engineering Limits: Culture, Diversity, and equity</td>
</tr>
<tr>
<td></td>
<td>ENGR 148 Principled Entrepreneurial Decisions ⁶</td>
</tr>
<tr>
<td></td>
<td>ME 267 Ethics and Equity in Transportation Systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Engineering Fundamentals ⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Two courses; see SoE Basic Requirement 3</td>
</tr>
<tr>
<td>8</td>
<td>CS 106A Programming Methodology ⁵</td>
</tr>
</tbody>
</table>

Select one of the following:

| ENGR 10 | Introduction to Engineering Analysis |
| ENGR 14 | Intro to Solid Mechanics |
| ENGR 15 | Dynamics |
| ENGR 20 | Introduction to Chemical Engineering |
| ENGR 21 | Engineering of Systems |
| ENGR 25B | Biotechnology |
| ENGR 25E | Energy: Chemical Transformations for Production, Storage, and Use |
| ENGR 40A | Introductory Electronics |
| ENGR 40M | An Intro to Making: What is EE |
| ENGR 50 | Introduction to Materials Science, Nanotechnology Emphasis |
| ENGR 50E | Introduction to Materials Science, Energy Emphasis |
| ENGR 50M | Introduction to Materials Science, Biomaterials Emphasis |
| ENGR 80 | Introduction to Bioengineering (Engineering Living Matter) |
| ENGR 90 | Environmental Science and Technology |

### Engineering Depth

<table>
<thead>
<tr>
<th>Units</th>
<th>Core Courses (all six required) ⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>CS 106B Programming Abstractions</td>
</tr>
<tr>
<td></td>
<td>ECON 50 Economic Analysis I</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 108 Senior Project (WIM)</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 111 Introduction to Optimization</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 111X Introduction to Optimization (Accelerated)</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 140 Accounting for Managers and Entrepreneurs</td>
</tr>
<tr>
<td></td>
<td>MS&amp;E 180 Organizations: Theory and Management</td>
</tr>
</tbody>
</table>

Area Courses (see below)

Choose four courses from a primary area and two courses from each of the other two areas.

### Depth Areas

#### Finance and Decision Area

Students choosing F&D as their primary area must take at least two of ECON 51, MS&E 145 (or 245A), and MS&E 152 (or 252).

Introductory (no prerequisites)

| ECON 143 | Finance and Society for non-MBAs |
| MS&E 152 | Introduction to Decision Analysis |

Intermediate (has prerequisites and/or appropriate for juniors and seniors)

| MS&E 145 | Introduction to Finance and Investment |
| MS&E 146 | Corporate Financial Management |
| MS&E 252 | Decision Analysis I: Foundations of Decision Analysis |

Advanced (intended primarily for graduate students, but may be taken by advanced undergraduates)

| MS&E 245A | Investment Science |

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² Select one of the following:

| PHYSICS 41 | Mechanics |
| PHYSICS 21 | Mechanics, Fluids, and Heat |
| PHYSICS 43 | Electricity and Magnetism |
| PHYSICS 23 | Electricity, Magnetism, and Optics |

³ Select one of the following:

| CHEM 31B | Chemical Principles II |

⁴ Select one of the following:

| CHEM 33 | Structure and Reactivity of Organic Molecules |

⁵ Select one of the following:

| CHEM 33 | Structure and Reactivity of Organic Molecules |

⁶ Select one of the following:

| PHYSICS 41 | Mechanics |
| PHYSICS 21 | Mechanics, Fluids, and Heat |
| PHYSICS 43 | Electricity and Magnetism |
| PHYSICS 23 | Electricity, Magnetism, and Optics |

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Management Science and Engineering (MS&E) Minor

The following courses are required to fulfill the minor requirements:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Background requirements</strong> (two courses; letter-graded or CR/NC)</td>
<td></td>
</tr>
<tr>
<td>CME 100 or MATH 51</td>
<td>5</td>
</tr>
<tr>
<td>Linear Calculus for Engineers, Multivariable Calculus, and Modern Applications</td>
<td></td>
</tr>
<tr>
<td>CS 106A</td>
<td>5</td>
</tr>
<tr>
<td>Programming Methodology</td>
<td></td>
</tr>
<tr>
<td><strong>Minor requirements</strong> (seven courses; all letter-graded)</td>
<td></td>
</tr>
<tr>
<td>MS&amp;E 111 or MS&amp;E 111X</td>
<td>3-4</td>
</tr>
<tr>
<td>Introduction to Optimization, Introduction to Optimization (Accelerated)</td>
<td></td>
</tr>
<tr>
<td>MS&amp;E 120</td>
<td>5</td>
</tr>
<tr>
<td>Probabilistic Analysis</td>
<td></td>
</tr>
<tr>
<td>MS&amp;E 121</td>
<td>4</td>
</tr>
<tr>
<td>Introduction to Stochastic Modeling</td>
<td></td>
</tr>
<tr>
<td>MS&amp;E 125</td>
<td>4</td>
</tr>
<tr>
<td>Introduction to Applied Statistics</td>
<td></td>
</tr>
<tr>
<td>MS&amp;E 180</td>
<td>4</td>
</tr>
<tr>
<td>Organizations: Theory and Management</td>
<td></td>
</tr>
<tr>
<td>Electives (select any two 100- or 200-level MS&amp;E courses)</td>
<td>6</td>
</tr>
<tr>
<td><strong>Recommended courses</strong></td>
<td></td>
</tr>
<tr>
<td>In addition to the required background and minor courses, it is</td>
<td></td>
</tr>
<tr>
<td>recommended that students also take the following courses.</td>
<td></td>
</tr>
<tr>
<td>ECON 50</td>
<td>5</td>
</tr>
<tr>
<td>Economic Analysis I</td>
<td></td>
</tr>
<tr>
<td>MS&amp;E 140</td>
<td>3-4</td>
</tr>
<tr>
<td>Accounting for Managers and Entrepreneurs (may be used as one of the</td>
<td></td>
</tr>
<tr>
<td>required electives above)</td>
<td></td>
</tr>
</tbody>
</table>

1. Students completing a calculus-based probability course such as CS 109 or STATS 116 for their major, may substitute another MS&E course for MS&E 120.

2. Students without AP/IB mathematics credit, who skip MATH 19, 20, 21, 41, and/or 42, may petition to waive up to 10 units of math.

3. AP/IB credit for Chemistry and Physics may be used.


5. Students may petition to waive CS 106A Programming Methodology. A course may only be counted towards one requirement; it may not be double-counted. For example, MS&E 193 may not count towards both TiS and towards the OTP depth area, and MS&E 111/ENGR 62 may not count towards both an engineering fundamental and towards the MS&E core depth.

6. All courses taken for the major must be taken for a letter grade. Minimum combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

**Management Science and Engineering Undergraduate Major**

**Operations and Analytics Area** 6-16

Students choosing O&A as their primary area may also include CS 161, CS 229, and STATS 202 in their selections.

**Methods**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS&amp;E 112</td>
<td>Mathematical Programming and Combinatorial Optimization</td>
</tr>
<tr>
<td>MS&amp;E 135</td>
<td>Networks</td>
</tr>
<tr>
<td>MS&amp;E 213</td>
<td>Introduction to Optimization Theory</td>
</tr>
<tr>
<td>MS&amp;E 223</td>
<td>Simulation</td>
</tr>
<tr>
<td>MS&amp;E 226</td>
<td>Fundamentals of Data Science: Prediction, Inference, Causality</td>
</tr>
<tr>
<td>MS&amp;E 231</td>
<td>Introduction to Computational Social Science</td>
</tr>
<tr>
<td>MS&amp;E 251</td>
<td>Introduction to Stochastic Control with Applications</td>
</tr>
</tbody>
</table>

**Applications**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS&amp;E 130</td>
<td>Information Networks and Services</td>
</tr>
<tr>
<td>MS&amp;E 232</td>
<td>Introduction to Game Theory</td>
</tr>
<tr>
<td>MS&amp;E 234</td>
<td>Data Privacy and Ethics</td>
</tr>
<tr>
<td>MS&amp;E 260</td>
<td>Introduction to Operations Management</td>
</tr>
<tr>
<td>MS&amp;E 263</td>
<td>Healthcare Operations Management</td>
</tr>
<tr>
<td>MS&amp;E 267</td>
<td>Service Operations and the Design of Marketplaces</td>
</tr>
<tr>
<td>MS&amp;E 330</td>
<td>Law, Bias, &amp; Algorithms</td>
</tr>
<tr>
<td>MS&amp;E 463</td>
<td>Healthcare Systems Design</td>
</tr>
</tbody>
</table>

**Organizations, Technology, and Policy Area** 6-16

Students choosing OT&P as their primary area must take at least two of ENGR 145, MS&E 175, MS&E 182A, MS&E 182B, MS&E 184, and MS&E 185.

**Introductory (no prerequisites)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 148</td>
<td>Principled Entrepreneurial Decisions</td>
</tr>
<tr>
<td>MS&amp;E 190</td>
<td>Methods and Models for Policy and Strategy Analysis</td>
</tr>
<tr>
<td>MS&amp;E 193</td>
<td>Technology and National Security: Past, Present, and Future</td>
</tr>
</tbody>
</table>

**Advanced (has prerequisites and/or appropriate for juniors and seniors)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 145</td>
<td>Technology Entrepreneur</td>
</tr>
<tr>
<td>MS&amp;E 175</td>
<td>Innovation, Creativity, and Change</td>
</tr>
<tr>
<td>or MS&amp;E 177</td>
<td>Inventing the Future</td>
</tr>
<tr>
<td>MS&amp;E 182A</td>
<td>Leading Organizational Change</td>
</tr>
<tr>
<td>MS&amp;E 182B</td>
<td>Leading Organizational Change II</td>
</tr>
<tr>
<td>MS&amp;E 184</td>
<td>Future of Work: Issues in Organizational Learning and Design</td>
</tr>
<tr>
<td>MS&amp;E 185</td>
<td>Global Work</td>
</tr>
<tr>
<td>MS&amp;E 188</td>
<td>Organizing for Good</td>
</tr>
<tr>
<td>MS&amp;E 243</td>
<td>Energy and Environmental Policy Analysis</td>
</tr>
<tr>
<td>MS&amp;E 292</td>
<td>Health Policy Modeling</td>
</tr>
</tbody>
</table>

**Electives** must come from the School of Engineering approved list or PSYCH 50 Introduction to Cognitive Neuroscience, and may not repeat material from any other requirement. AP/IB credit for Chemistry and Physics may be used if not used above.