# Assessment plan Master Industrial Engineering and Management (IEM) 2023-2024

## Introduction

This assessment plan is a systematic description of the type of assessment used in the various modules of the Master's Degree Programme Industrial Engineering and Management. This assessment plan fits within the assessment policy of the Faculty of Science and Engineering[1], and the protocol used by the Board of Examiners of the degree programme [2].

The assessment plan is based on:

1. The (appendices of the) Teaching and Examination regulations of the degree programme;
2. The description of the various modules of the degree programme in the digital course catalogue *Ocasys*, including:
   - Objective of the module
   - Course content
   - Lecturers and examiners
   - Assessment method used
   - Lecture format

## Assessment plan

The assessment plan contains the following items:

1. Mission and objectives of the degree programme
2. Learning outcomes of the degree programme
3. An overview of examiners and assessment type used for all modules in the IEM master's programme. The following types of assessments are distinguished in this scheme:
   - *Examples of assessment modes include:*
   - *Written exam with open questions (WE)*
   - *Written exam with multiple-choice questions (MC)*
   - *Oral exam (OR)*
   - *Report (R)*
   - *Presentation (P)*
   - *Interim test (IT)*
   - *Assignment (AST)*
   - *Practical work (PR)*
   - *Other assessment mode to be specified (ALT)*
4. A list of lecturers qualified to supervise IEM master's (design and research) projects, including the IEM specialization of each supervisor;
5. A matrix describing the relation between the various modules of the programme and the specified learning outcomes of the degree programme.

[1] FSE Quality Assurance Manual (2018-2019)
https://myuniversity.rug.nl/infonet/medewerkers/fse/education/quality-assurance/documenten/quality-assurance-manual-fse.pdf

[2] Protocol for the duties and powers of the Board of Examiners of the Faculty of Science and Engineering (2014)
https://myuniversity.rug.nl/infonet/medewerkers/fse/education/policy-quality-education/documents/fmns-protocol-board-of-examiners.pdf

**Mission and objectives of the degree programme**
The mission of the Industrial Engineering and Management master's degree programme is "to educate industrial engineers who innovate with technological solutions for managerial/business problems".

This mission is translated into the following objectives of the master's degree programme Industrial Engineering and Management:

1. The programme aims to teach students the knowledge, skills and understanding in the field of industrial engineering and management to (re)design (complex) technological processes and products in a managerial/business context, i.e. including implementation of the (re)design and evaluation of the implementation.
2. The programme aims to prepare students for an academic career in industrial engineering and management-oriented research or a career as an industrial engineer.
3. The programme aims to give students an academic training with respect to:
   - Autonomous critical thinking and acting;
   - Scientific communication in English.

**Learning outcomes of the Master's degree programme Industrial Engineering and Management**
After the master's degree programme students have:
1. The knowledge to describe complex and advanced technological processes and products in a managerial/business context.
2. The understanding to diagnose the functionality and performance of such processes and products in a multi-disciplinary way (e.g. technological, managerial and form viewpoint of various stake-holders).
3. The skills to (re)design, implement and then evaluate such processes and products.
4. The knowledge, understanding and skills for doing research, i.e. applying industrial engineering methodologies in research.
5. The knowledge, understanding and skills for life-long learning (including information retrieval and ICT-use) needed to function autonomously.
6. The skills to think critically and communicate scientifically about ideas and solutions with engineers and managers.
7. The knowledge and understanding of advanced technology, managerial/business sciences and mathematics to do research and to enter a PhD program in Industrial Engineering or a related discipline.
8. Professional skills for managerial, societal and ethical behaviour when applying technology.

**Examiners and assessment type of modules in the degree programme**

| **PTL track** | | | | |
|---|---|---|---|---|
| **Module** | **ECTS** | **Course coordinator/ First examiner** | **Second examiner** | **Examination type** |
| Foundations of Logistics Systems Engineering (WMIE002-05) | 5 | prof. dr. D. Bauso | S.G. Ramirez Juarez, M | R, WE |
| Robotics for IEM (WMIE005-05) | 5 | dr. B. Haghighat | prof. dr. ir. B. Jayawardhana | R, WE |
| Technology Based Entrepreneurship (WMIE006-05) | 5 | dr. A.J. Frederiks | dr. S.R. White | AST, WE |
| Simulation of Logistic Systems (WMIE012-05) | 5 | dr. ing. A. Hübl | ir. T.M. Kousemaker | AST, PR, WE |
| Surface Engineering and Coating Technology (WMIE013-05) | 5 | prof. dr. Y. Pei | dr. A.G.P. Kottapalli | AST, R, WE |
| Analysis and Control of Smart Systems (WMIE015-05) | 5 | prof. dr. C. De Persis | dr. N. Monshizadeh Naini | WE |
| Sustainable Industrial Practise (WMIE027-05) | 5 | dr. ir. G.H. Jonker | TBD | AST, P, R |
| Systems Engineering (WMIE021-05) | 5 | dr. N.B. Szirbik | prof. dr. A. Vakis | IT, P, AST |
| 4 PTL Electives | 20 | Various | | VAR |
| Research Methodology (WMIE025-05) | 5 | dr. ing. H. Kloosterman | M. Mohebbi, MSc | OR, R |
| Master's Design Project IEM (WMIE901-25) | 25 | See table: IEM Master's Supervisors | | OR, P, R, PR |
| Master's Research Project IEM (WMIE901-30) | 30 | See table: IEM Master's Supervisors | | P, R, PR |

| **PTL electives** | | | | |
|---|---|---|---|---|
| **Module** | **ECTS** | **Course coordinator/ First examiner** | **Second examiner** | **Examination type** |
| Introduction to Optimization (WMIE031-05) | 5 | prof. dr. J.G. Peypouquet | prof. dr. M.K. Camlibel | AST, PR, WE |
| Multibody and Non-Linear Dynamics (WMME009-05) | 5 | dr. A.O. Krushynska | prof. dr. ir. B. Jayawardhana | P, PR, R, WE |
| Fitting Dynamical Models to Data (WMIE007-05) | 5 | prof. dr. ir. B. Jayawardhana | Prof. dr. M. Cao | WE |
| Game Theory with Engineering Applications (WMIE009-05) | 5 | prof. dr. D. Bauso | S.G. Ramirez Juarez, M | P, R, WE |
| MEMS, NEMS and Nanofabrication (WMIE010-05) | 5 | dr. A.G.P. Kottapalli | prof. dr. Y. Pei | WE, IT |
| Multiscale Contact Mechanics and Tribology (WMIE011-05) | 5 | prof. dr. A. Vakis | dr. F. Maresca | AST, WE |
| Characterisation of Materials (WMPH021-05) | 5 | dr. G.R. Blake | Prof. dr. B.J. Kooi | WE |

| | | | | |
|---|---|---|---|---|
| Compressible Flows (WMCE008-05) | 5 | dr. ir. P.D. Druetta | prof. dr. F. Picchioni | AST, WE, PR, R |
| Device Physics (WMPH050-05) | 5 | prof. dr. ir. B.J. van Wees | prof. dr. T. Banerjee | P, R, WE |
| Engineering Design Integration (WMIE029-05) | 5 | prof. dr. ir. D. Lentink | dr. E.J. Stamhuis | AST, P, R |
| Mechanical Properties (WMPH023-05) | 5 | prof. dr. ir. E. van der Giessen | prof. dr. ir. P.R. Onck | AST, PR, P, R |
| Modeling and Control of Complex Nonlinear Engineering Systems (WMMA020-05) | 5 | dr. ir. B. Besselink | prof. dr.ir. J.M.A. Scherpen | AST, WE |
| Optimization in Engineering Systems (WMIE026-05) | 5 | dr. N. Monshizadeh Naini | prof. dr. C. De Persis | AST, WE |
| Product Design by the Finite Element Method (WMIE003-05) | 5 | TBD | TBD | AST |
| CFD for Engineers (WMCE013-05) | 5 | dr. ir. P.D. Druetta | prof. dr. F. Picchioni | AST, WE, R |
| Composites and Metamaterials (WMME031-05) | 5 | dr. A.O. Krushynska | prof. dr. ir. B Jayawardhana | AST, P, R, MC, IT |
| Data-driven Optimization (WMME011-05) | 5 | dr. A.K. Cherukuri | prof. dr. D. Bauso | AST, WE |
| Introduction to Stochastic Programming (WMIE019-05) | 5 | dr. A.K. Cherukuri | prof. dr. D. Bauso | WE, AST |
| Mathematical Modelling (WMIE033-05) | 5 | prof. dr. ir. R.W.C.P. Verstappen | prof. dr. S. Trenn | AST |
| Numerical Mathematics 1 (WMIE032-05) | 5 | dr. C.A. Bertoglio | dr. J. Koellermeier | A, WE |

| **SPE-Track** | | | | |
|---|---|---|---|---|
| **Module** | **ECTS** | **Course coordinator/ First examiner** | **Second examiner** | **Examination type** |
| Bioprocesses for Engineers (WMIE028-05) | 5 | dr. ir. T.H.J.A. Sleutels | prof. dr. G.J.W. Euverink | R |
| Catalysis for Engineers (WMCE002-05) [option A]* | 5 | prof. dr. ir. H.J. Heeres | dr. ir. J. Xie | WE |
| Interfacial Engineering (WMCE003-05) [option B]* | 5 | dr. P. Raffa | prof. dr. F. Picchioni | AST, WE |
| Technology Based Entrepreneurship (WMIE006-05) | 5 | dr. A.J. Frederiks | dr. S.R. White | AST, WE |
| Advanced LCA for Sustainability (WMIE034-05) | 5 | dr. P. Karka | dr. ir. G.H. Jonker | |
| Advanced Product Engineering (WMCE007-05) | 5 | prof. dr. F. Picchioni | dr. R.K. Bose | P, R |
| Advanced Process and Energy Technologies (WMCE012-05) | 5 | prof. dr. J. Yue | dr. V. Kyriakou | P, R, IT |
| Sustainable Industrial Practise (WMIE027-05) | 5 | dr. ir. G.H. Jonker | TBD | AST, P, R |
| Systems Engineering (WMIE021-05) | 5 | dr. N.B. Szirbik | prof. dr. A. Vakis | AST, P |

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|---|---|---|---|---|
| 4 SPE electives | 20 | Various | | VAR |
| Research Methodology (WMIE025-05) | 5 | dr. ing. H. Kloosterman | M. Mohebbi, MSc | OR, R |
| Master's Design Project IEM (WMIE901-25) | 25 | See table: IEM Master's Supervisors | | OR, P, R, PR |
| Master's Research Project IEM (WMIE901-30) | 30 | See table: IEM Master's Supervisors | | P, R |

* Students choose either option A or B as a mandatory course. Students can take the other course as an SPE elective (CE specialization) as well.

| **SPE electives** | | | | |
|---|---|---|---|---|
| **Module** | **ECTS** | **Course coordinator/ First examiner** | **Second examiner** | **Examination type** |
| Bio-based Products (WMCE001-05) | 5 | prof. dr. P.J. Deuss | dr. ir. J. Xie | P, R |
| Catalysis for Engineers (WMCE002-05) | 5 | prof. dr. ir. H.J. Heeres | dr. ir. J. Xie | WE |
| Interfacial Engineering (WMCE003-05) | 5 | dr. P. Raffa | prof. dr. F. Picchioni | AST, WE |
| Advanced Instrumentation and Analytics in Biotechnology (WMIE023-05) | 5 | prof. dr. G.J.W. Euverink | dr. J. Krooneman | R |
| Food Pharma Products (WMIE008-05) | 5 | prof. dr. G.J.W. Euverink | dr. J. Krooneman | R |
| Microfluidics (WMME020-05) | 5 | prof. dr. J. Yue | prof. dr. G.J.W. Euverink | P, R |
| Advanced Polymer Processing (WMCE006-05) | 5 | dr. D. Parisi | dr. ir. P.D. Druetta | AST, WE, PR |
| Bioprocess Technology (WMIE018-05) | 5 | dr. ir. T.H.J.A. Sleutels | prof. dr. G.J.W. Euverink | AST, P |
| Characterisation of Materials (WMPH021-05) | 5 | dr. G.R. Blake | Prof. dr. B.J. Kooi | WE |
| Circular Polymers (WMCE017-05) | 5 | prof. dr. R. Duchateau | prof. dr. F Picchioni | P, WE |
| Compressible Flows (WMCE008-05) | 5 | dr. ir. P.D. Druetta | prof. dr. F. Picchioni | AST, WE, PR, R |
| Design of Industrial Catalysts (WMCE009-05) | 5 | prof. dr. P.P. Pescarmona | dr. V. Kyriakou | P, R, IT |
| Engineering Design Integration (WMIE029-05) | 5 | prof. dr. ir. D. Lentink | dr. E.J. Stamhuis | AST, P, R |
| Product Focused Process Design (WMCE011-05) | 5 | prof. dr. ir. G. Versteeg | dr.ir. J.G.M. Winkelman | OR, R |
| CFD for Engineers (WMCE013-05) | 5 | dr. ir. P.D. Druetta | prof. dr. F. Picchioni | AST, R, WE |

*For courses owned by other degree programmes, please refer to their assessment plans for more information.

**IEM Master's Design Project Supervisors**

| Title | Initials | Last Name | Research group/ Department |
|---|---|---|---|
| dr. ing. | A. | Hübl | Design group |
| dr.ir. | G.H. | Jonker | Design group |
| dr. ing. | H. | Kloosterman | Design group |
| ir. | T.M. | Kousemaker | Design group |
| dr. | G.K.H. | Larsen | Design group |
| dr. | M. | Muñoz Arias | Design group |
| dr. | F. | Ruzenetti* | ESRIG |
| dr. ir. | T.H.J.A. | Sleutels | Products and Processes for Biotechnology |
| dr. | N.B. | Szirbik | Design group |

* 2nd examiner only

**IEM Master's Research Project Supervisors**

| Title | Initials | Last Name | Research group/ Department | Research Institute |
|---|---|---|---|---|
| dr. | M.I. | Acuautla Meneses | Discrete Technology and Production Automation | ENTEG |
| prof. dr. ir. | P. | Avgeriou | Software Engineering | JBI |
| prof. dr. | D. | Bauso | Optimization and Decision Systems | ENTEG |
| dr. | R.K. | Bose | Product Technology | ENTEG |
| prof. dr. ir. | M. | Cao | Discrete Technology and Production Automation | ENTEG |
| dr. | A.K. | Cherukuri | Optimization and Decision Systems | ENTEG |
| prof. dr. | C. | De Persis | Smart Manufacturing Systems | ENTEG |
| dr. | P.J. | Deuss | Chemical Technology | ENTEG |
| dr. ir. | P.D. | Druetta | Product Technology | ENTEG |
| prof. dr. ir. | M. van | Duin | Product Technology | ENTEG |
| prof. dr. | G.J.W. | Euverink | Products and Processes for Biotechnology | ENTEG |
| dr. | A.J. | Frederiks | Innovation management & Strategy | FEB |
| prof. dr. | A.J. | Groen | University of Groningen Centre of Entrepreneurship | University College |
| prof. dr. ir. | H.J. | Heeres | Chemical Technology | ENTEG |
| dr. ing. | A. | Hübl | Design group | |
| prof. dr. | B. | Jayawardhana | Discrete Technology and Production Automation | ENTEG |
| dr. ir. | G.H. | Jonker | Lecturers Industrial Engineering Systems | Design Group |
| dr. | E. | Jurak | Bioproduct Engineering | ENTEG |
| prof. dr. | N. | Kalantar-Nayestanaki | Research Unit Nuclear & Hadron Physics | ESRIG |
| prof. dr. ir. | B.J. | Kooi | Nanostructured Materials and Interfaces | ZIAM |
| dr. | J. | Kosinka | Scientific Visualization and Computer Graphics | JBI |
| dr. | A.G.P. | Kottapalli | Advanced Production Engineering | ENTEG |
| dr. | J. | Krooneman | Products and Processes for Biotechnology | ENTEG |
| dr. | A.O. | Krushynska | Computational Mechanical and Materials Engineering | ENTEG |
| prof. dr. | M.J.E.C. | Maarel, van der | Bioproduct Engineering | ENTEG |

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|---|---|---|---|---|
| dr. | N. | Monshizadeh Naini | Smart Manufacturing Systems | ENTEG |
| dr. | M. | Muñoz Arias | Lecturers Industrial Engineering Systems | Design Group |
| prof. dr. ir. | P.R. | Onck | Micromechanics | ZIAM |
| prof. dr. | Y. | Pei | Advanced Production Engineering | ENTEG |
| dr. | P.P. | Pescarmona | Product Technology | ENTEG |
| prof. dr. | F. | Picchioni | Product Technology | ENTEG |
| prof. dr. | A. | Purushothaman Vellayani | Energy Conversion | ESRIG |
| dr. | G. | Portale | Macromolecular Chemistry & New Polymeric Materials | ZIAM |
| prof. dr. ir. | J. | Post | Advanced Production Engineering | ENTEG |
| drs. | W.A. | Prins | Advanced Production Engineering | ENTEG |
| dr. | P. | Raffa | Product Technology | ENTEG |
| prof. dr. ir. | J.M.A. | Scherpen | Discrete Technology and Production Automation | ENTEG |
| dr. ir. | T.H.J.A. | Sleutels | Products and Processes for Biotechnology | ENTEG |
| prof. dr. | A. | Vakis | Advanced Production Engineering | ENTEG |
| dr. | S.R. | White | University of Groningen Centre of Entrepreneurship | University College |
| prof. dr. | M.J.H. | Witjes | | Faculty of Medical Sciences |
| dr. ir. | J.G.M. | Winkelman | Chemical Technology | ENTEG |
| prof. dr. | J. | Yue | Chemical Technology | ENTEG |

**Relation between the learning outcomes and the curriculum**

There are two tracks within the Master's degree programme IEM:
1. Production Technology and Logistics (PTL)
2. Sustainable Process Engineering (SPE).

The tracks on the one hand provide students with the opportunity to gain specialist knowledge in a specific technological field, and on the other hand globally divide their future field of work.
In order to specify the learning outcomes of the programme for these tracks, we distinguish four competence area's (general academic skills are assimilated into these competence area's).

General competence area's (applicable for all tracks):
E: Industrial engineering (outcomes 1, 4, 5, 6, 7, 8)
M: Managerial and business sciences (outcomes 6, 7, 8)

Competence area per track:
P: Production Technology and Logistics (PTL) (outcomes 2, 3)
S: Sustainable Process Engineering (SPE) (outcomes 2, 3)

The specification of the learning outcomes of the programme for each competence area is as follows:
*Industrial engineering (E)*
In the area of industrial engineering students have:
E1. Knowledge and understanding of (advanced) design and engineering theories.
E2. Skills to apply engineering and technology concepts for solving theoretical (research) and practical (industrial/managerial) problems.
E3. Skills to justify and communicate about their problem-solving approach from a multidisciplinary point of view.

*Managerial and business science (M)*
In the area of managerial and business sciences students have:
M1. Sufficient knowledge and understanding of managerial and business sciences to enter PhD programs in Industrial Engineering (and related fields).
M2. Skills to choose and apply organizational (including information), psychological, financial and marketing methods and concepts for adequately solving real-life business problems.
M3. Skills to implement, justify and communicate about their problem-solving approach from a multidisciplinary point of view.

*Production technology and logistics (P)*
In the area of production technology and logistics students have:
P1. Advanced knowledge and understanding of production technology and logistical engineering, to enter PhD programs in IEM related to production technology and logistical engineering.
P2. Skills to analyse, (re)design, and implement (innovative) solutions for (complex) discrete products and production system problems, taking into account realistic industrial constraints (economic, safety, manufacturability, sustainability etc.).
P3. Skills to effectively operate as employee (technologist, market analyst/developer, manager) in the discrete product engineering, production engineering and logistical engineering business; both at commercial production and support (services) level.

*Sustainable Process Engineering (S)*
In the area of sustainable process engineering students have:
S1. Advanced knowledge and understanding of (bio)chemical engineering, chemical product engineering and biotechnology to enter PhD programs in (Bio)Chemical Product or Process Design and Engineering or Biotechnology.
S2. Skills to analyse real-life industrial (bio)chemical process and product design problems and to develop solutions on the basis of the scientific fundamentals used in these disciplines.
S3. Skills to effectively operate as employee (technologist, market analyst/developer, manager) in the (bio)chemical processing and production businesses or biotechnology businesses; both at commercial production and support (services) level.

In the tables below, ❁ represents a major contribution to the learning outcome, and ✶ a minor contribution to the learning outcome.

| Specialization PTL | **E1** Design & Engineering theories (K) | **E2** Apply engineering & technology concepts (S) | **E3** Justify and communicate (S) | **M1** Management and business sciences (K) | **M2** Choose/apply Business methods/concepts (S) | **M3** Implement, justify and communicate (S) | **P1** Production technology and logistics (K) | **P2** Analysis. design & implement solutions (S) | **P3** Effectively operate in Business (S) | **S1** Chemical (product) engineering (K) | **S2** Analysis. design & implement solutions (S) | **S3** Effectively operate in Business (S) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sustainable Industrial Practice | ❁ | ❁ | ❁ | | ❁ | ❁ | | | | | | |
| Technology Based Entrepreneurship | | | | ❁ | ❁ | ❁ | | ❁ | ❁ | | | |
| Systems Engineering | ❁ | ❁ | ❁ | | | | | ❁ | | | | |
| Master's Design Project IEM | | ❁ | ❁ | | ❁ | ❁ | | ❁ | ❁ | | | |
| Master's Research Project IEM | | ❁ | ❁ | | ❁ | ❁ | | ❁ | ❁ | | | |
| Research Methodology | | | ✶ | ✶ | ✶ | ✶ | | | | | | |
| Foundations of Logistic Systems Engineering | ❁ | ❁ | | ❁ | ❁ | | | | | | | |
| Simulation of Logistic Systems | ❁ | ❁ | ❁ | ❁ | ❁ | ❁ | ❁ | ❁ | ❁ | | | |
| Robotics for IEM | ❁ | ❁ | | | | | ❁ | ❁ | | | | |
| Surface Engineering & Coating Technology | ❁ | ❁ | | | | | ❁ | ❁ | | | | |
| Analysis and Control of Smart Systems | ❁ | ❁ | | | | | ❁ | ❁ | | | | |
| Electives | | | | | | | | | | | | |

K =knowledge, S = Skills

| Specialization SPE | **E1** Design & Engineering theories (K) | **E2** Apply engineering & technology concepts (S) | **E3** Justify and communicate (S) | **M1** Management and business sciences (K) | **M2** Choose/apply Business methods/concepts (S) | **M3** Implement, justify and communicate (S) | **P1** Production technology and logistics (K) | **P2** Analysis. design & implement solutions (S) | **P3** Effectively operate in Business (S) | **S1** Chemical (product) engineering (K) | **S2** Analysis. design & implement solutions (S) | **S3** Effectively operate in Business (S) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sustainable Industrial Practice | ❋ | ❋ | ❋ | | ❋ | ❋ | | | | | | |
| Technology Based Entrepreneurship | | | | ❋ | ❋ | ❋ | | | | | ❋ | ❋ |
| Systems Engineering | ❋ | ❋ | ❋ | | | | | | | | ❋ | |
| Master's Design Project IEM | | ❋ | ❋ | | ❋ | ❋ | | | | | ❋ | ❋ |
| Master's Research Project IEM | | ❋ | ❋ | | ❋ | ❋ | | | | | ❋ | ❋ |
| Research Methodology | | | ❋ | ❋ | ❋ | ❋ | | | | | | |
| Interfacial Engineering | ❋ | ❋ | | | | | | | | ❋ | ❋ | ❋ |
| Advanced LCA for Sustainability | | | | | | | | | | | | |
| Advanced Product Engineering | ❋ | ❋ | | ❋ | ❋ | | | | | ❋ | ❋ | ❋ |
| Advanced Process and Energy Technologies | ❋ | ❋ | ❋ | | | | | | | ❋ | ❋ | |
| Electives | | | | | | | | | | | | |

K = knowledge, S = Skills