HANDBOOK
2022

MEng / PG Diploma in

Manufacturing Systems Engineering

Department of Mechanical Engineering
University of Moratuwa
Sri Lanka

Contents

1 Introduction

The curriculum of the Postgraduate studies in Manufacturing Systems Engineering enhances the knowledge and skills of the participants in many areas. Some of the specific objectives of the course are;

- To provide a sound knowledge of the advanced aspects of manufacturing processes and to introduce recent advances in manufacturing technology with respect to process, machinery, materials, and tooling.
- To provide the understanding of the complete product development process and impart the knowledge required for developing a successful product.
- To improve the students' knowledge and skills of computer-aided draughting and design, and operation & programming of computer controlled manufacturing systems.
- To provide general management background needed by the manufacturing executives for effectively participating in the total business environment of a firm.
- To provide the knowledge and skills required in automating and controlling the functions of the manufacturing processes.
- To enhance the understanding of the impact of human capabilities and limitations on the design and development of products and equipment.
- To develop the skill of handling challenging design/research projects.

2 Structure of the Programme

2.1 Eligibility Requirement

1. The Degree of Bachelor of Science of Engineering of the University of Moratuwa in Mechanical Engineering/Textile and Clothing Technology/Materials Science and Engineering/Chemical Engineering/Electrical Engineering,

OR

2. Any other engineering degree of at least four years duration, from a recognised University, in a relevant field of specialization as may be approved by the Senate,

OR

3. Any recognized category of membership of a recognized Professional Institute, obtained through an academic route, **WITH** a minimum of one year of recognized appropriate experience obtained after the membership, as may be approved by the Senate.

Note: (a) More suitable for those with a Mechanical or Production Engineering Degree.

(b) Preference will be given to those who are employed in a relevant field.

2.2 Duration of Programme of Study

1. The Duration of Study of a candidate is reckoned as the period between the effective date of initial registration for the programme, and the date of award of the degree.
2. The minimum duration of Study leading to the Postgraduate Diploma, for a candidate, shall be 12 months.
3. The permitted duration to complete the Postgraduate Diploma, as reckoned from the effective date of registration shall be 24 months.
4. The maximum duration to complete the Postgraduate Diploma, as reckoned from the effective date of registration,
    a. shall usually correspond to the permitted duration
    b. can be extended by the Senate on the recommendation of the Faculty for **up to 48 months**, on a case-by-case basis, giving reasons for such recommendation by the Faculty.

2.3 Curriculum and Scheme of Evaluation

All lectures, tutorials, assignments, laboratory work, seminars, etc. will normally be conducted in a three-term academic year on Saturdays and Sundays. Those who proceed to the MEng degree will be required to do a Research Project in the second year.

Year 1 - Term 1:

Compulsory Courses:

Code	Course Module	Credits	Evaluation	
			Continuous Assessment	Written Exam
ME5101	Decision Analysis for Manufacturing Management	3	20%	80%
ME5102	Production and Operations Management	3	30%	70%
ME5103	Computer Integrated Manufacturing	3	30%	70%
ME5104	Manufacturing Processes	3	30%	70%

Total credit requirement in Term 1 = 12

Year 1 - Term 2:

Compulsory Courses:

Code	Course Module	Credits	Evaluation	
			Continuous Assessment	Written Exam
ME5120	Computer Aided Design and Manufacture	3	40%	60%
ME5121	Industrial Management	3	20%	80%

Elective Courses (Two to be selected):

Code	Course Module	Credits	Evaluation	
			Continuous Assessment	Written Exam
ME5122	Quality Management	3	30%	70%
ME5123	Supply Chain Management	3	30%	70%
ME5124	Automation and Control of Manufacturing Systems	3	40%	60%
ME5125	Manufacturing Processes: Advanced Aspects	3	30%	70%

Total credit requirement in Term 2 = 12

Year 1 - Term 3:

Compulsory Courses:

Code	Course Module	Credits	Evaluation	
			Continuous Assessment	Written Exam
ME5140	Product Design	3	40%	60%
ME5141	Special Studies	4	100%	----

Elective Courses (Three to be selected):

Code	Course Module	Credits	Evaluation	
			Continuous Assessment	Written Exam
ME5142	Design of Manufacturing Systems	3	30%	70%
ME5143	Manufacturing Strategy	3	20%	80%
ME5144	Mechatronics and Robotics	3	40%	60%
ME5145	Artificial Intelligence in Manufacturing	3	30%	70%
ME5146	Human Factors Engineering	3	30%	70%
ME5147	Sustainable Manufacturing	3	40%	60%

Total credit requirement in Term 3 = 16

Total Credit Requirement for PG Diploma: 40 Credits

Year 2:

Code	Course Module	Credits	Evaluation	
			Continuous Assessment	Written Exam
	MEng Research Project	20	100%	---

Total Credit Requirement for MEng: 40 + 20 Credits = 60 Credits

3 Syllabi of Course Units

ME5101- Decision Analysis for Manufacturing Management

Course Objectives:
To provide the student with the Operations Research (OR) foundation required for modelling and decision making in manufacturing organisations.

Learning Outcomes:
The students should be able to:

- Apply linear programming techniques for system optimisation,
- Use software applications to solve LP problems,
- Use probability theory to model random processes,
- Apply Queuing theory for manufacturing systems applications, and
- Apply the techniques in the context of real decision making in manufacturing organization.

Syllabus:
Mathematical Modelling for decision support; Linear programming: Simplex method, Software for solving LP (LINDO, LINGO); Nonlinear programming and integer programming; Dynamic programming; Network models; Probability and statistics; Modelling random process; Queuing theory – applications in manufacturing systems.

Recommended Text:

- Operations Research: An Introduction – 7th Edition by Hamdy A Taha
- Operations Research by R Panneerselvam

ME5102 – Production and Operations Management

Course Objectives:
To make the student grasp the techniques of production and operations management as applied in manufacturing environment.

Learning Outcomes:
The students should be able to:

- Planning facilities of a production system,
- Address the aspects of production planning, scheduling, control and other related issues in production systems, and
- Apply latest techniques of production management to improve the product quality and productivity.

Syllabus:
Nature and context of Production Management; Production and operations strategy; Demand management and forecasting; Production planning and control; Inventory and materials management, MRP, MRPII, ERP; Just-in-Time (JIT) production; Shop flow scheduling and control; Facility location and layout; Assembly lines: Line balancing; Synchronous Manufacturing; Quality Management; Maintenance management; Productivity improvement, Behavioural, social and legal factors influencing manufacturing management decisions.

Recommended Text:

- Operations Management for Competitive Advantage – 11th Edition by Chase RB, Aquilano NJ, Jacobs FR
- Production and Operations Management, Principles and Techniques by Wild, Ray
- Modern Production / Operations Management by Buffa, Elwood S
- Production and Operations Management: Concepts, Models and Behaviour, 5th Edition by Everett E Adams and Ronald J Ebert

ME5103 – Computer Integrated Manufacturing

Course Objectives:
To acquaint the student with the integration of the elements of CAD and CAM and the integration of manufacturing functions.

Learning Outcomes:
The students should be able to:

- Plan the production processes based on computer aided process planning techniques,
- Implement concepts of computer integrated manufacturing,
- Use data logging and acquisition techniques to gather production process related data for the purpose of process controlling and monitoring, and
- Develop database management systems to facilitate computer integrated manufacturing

Syllabus:
Integrated approach in manufacturing systems; Concurrent engineering; Production process design; Group technology; Computer aided process planning; Production management aspects of CIM; Implementation of CIM; Flexible manufacturing systems (FMS); Factory of future; Communication networks, DBMS, Interfacing, Data logging and acquisition.

Recommended Text:

- CAD /CAM Principles Practice and Manufacturing Management by Chris McMahon and Jimmie Browne
- Computer Aided Production Management by PB Mahapatra

ME5104 – Manufacturing Processes

Course Objectives:
To provide an overview (and a review) of the manufacturing methods for metallic and non-metallic materials covering their critical aspects and with reference to local manufacturing industry.

Learning Outcomes:

The students should be able to:

- Select appropriate manufacturing method for a given requirement, and
- Evaluate the merits and demerits of different manufacturing methods.

Syllabus:
An overview of local manufacturing industry; Mechanical behaviour and manufacturing properties of materials; Casting Technology: Metals and melting practice, Design aspects of product/mould, product quality; Forming Technology: General characteristics, bulk forming vs sheet-metal working, formability, analysis of process with respect to machinery and tooling, forming loads and energy requirements, product quality concerns; Joining Processes (for metals): Process classification, fusion weld quality and weld metallurgy, testing and inspection; Forming and shaping of fibre reinforced materials; Processing of powder materials and ceramics: Sintering technology; Non-conventional Machining Processes: CM, ECM, EDM, laser/electron beam machining, water/abrasive-jet machining, etc.; Surface treatment and coating: methods and technology.

Recommended Text:

- Introduction to Manufacturing Processes by John A Schey
- Manufacturing Engineering & Technology by Serope Kalpakjian, Steven R Schmid
- Materials & Processes in Manufacturing by E Paul Degarmo, JT Black, Ronal A Kohser

ME5120 – Computer Aided Design and Manufacture

Course Objectives:
To provide the student with knowledge and skills of computer-aided draughting and design, and operation and programming of computer controlled manufacturing systems.

Learning Outcomes:
The students should be able to:

- Develop 3 dimensional graphical models using application software,
- Model and analyse engineering artefacts using FEA software,
- Generate part programmes for CNC machining, and
- Use reverse engineering techniques in absence of design data.

Syllabus:
Graphical support hardware; Graphics software; Geometric modelling; CAD-User interface; Application areas of CAD, FEM; Rapid prototyping and desktop manufacturing.

Fundamentals of NC; Taxonomy of CNC/DNC machine tools, Programming of NC, Computer-based Engineering Metrology, Co-ordinate Measuring Machine (CMM).

Recommended Text:

- CAD/CAM Computer-Aided Design &Manufacturing by Mikell P. Groover, Emony W Zimmers
- Computer Numerical control – A CNC Reference Guide by Hans B Kief & T. Fedrick Waters

ME5121 – Industrial Management

Course Objectives:
To provide the general management background needed by the manufacturing executive for effectively participating in the total business environment of a firm.

Learning Outcomes:

The students should be able to:

- Identify critical human factors that affect the smooth functioning of an organization,
- Manage human resources effectively in an organization,
- Make informed decisions regarding financial aspects of an organization, and
- Develop effective marketing strategies.

Syllabus:
Human factors in industry: Organisation structure, Cultures and management styles, leadership and characteristics of individuals, group behaviour, Manpower requirements and skill needs-selection recruitment and training, Motivation, Rewards strategies- reward and job evaluation, Implementing changes in organisation.

Financial decision making: Financial analysis, Profitability analysis, and Investment appraisal.

Marketing: Concepts and importance of marketing, Marketing system, Market types, Marketing research and analysis, Managing marketing mix, Four P's (Product, Price, Place, Promotion).

Recommended Text:

- Engineering Economics by R Panneerselvam

ME5122 – Quality Management

Course Objectives:
To present quality as a strategic tool for competitiveness and to provide knowledge of the ways and means to achieve quality in manufacturing.

Learning Outcomes:
The students should be able to:

- Apply latest techniques for quality management,
- Use statistical quality control methods for process control,
- Design sampling plans for quality control, and
- Incorporate quality aspects at the design stage of products.

Syllabus:
Quality management systems: Quality management philosophies, Total Quality Management, Quality awards (Malcom Baldrige award, National Quality award), Quality certification (ISO 9000, SLS) HRM for quality, Vendor quality; Statistical quality control: Statistical methods in QC, Statistical process control, Acceptance sampling, Taguchi method, Product reliability; Design for quality, Quality function deployment.

Recommended Text:

- Total Quality Management by Dale H Besterfield and Glen H Besterfield
- Quality Control And Applications by Hansen BL, Prentice-Hall, ISBN 81-203-0794-1
- Quality Control and Applications by Bertrand L Hansen and Prabhakar M Ghare

ME5123 – Supply Chain Management

Course Objectives:

To support the globalisation trends in manufacturing systems by developing the management know-how required by the students aspiring to work in international business.

Learning Outcomes:

The students should be able to:

- Effectively Manage a supply chain of a production organization,
- Implement and manage ERP systems, and
- Organize and maintain information management systems.

Syllabus:

The concept and structure of Global Supply Chain; International trade; Supply organisation; The procurement process; Distribution management; Transportation systems; Enterprise resource planning; Management and organisation of information systems; Strategic considerations.

Recommended Text:

- Supply Chain Management – Strategy, Planning and Operation by: Sunil Chopra and Peter Meindl
- Purchasing and Supply Chain Management by: Kenneth Lysons and Michael Gillingham
- Supply Chain Management and Advanced Planning by: Hartmut Stadtler and Christoph Kilger
- Strategic Purchasing and Supply Chain Management by: Malcolm Saunders

ME5124 – Automation and Control of Manufacturing Systems

Course Objectives:
To provide the knowledge and skills required automating and controlling the functions of the manufacturing process.

Learning Outcomes:

The students should be able to:

- Understand the control theory and it's applications to manufacturing organizations,
- Develop basic applications using electronic controllers and Programmable Logic Controllers,
- Design and implement micro-level automation using the controllers mentioned 2 above, and
- Maintenance and diagnosis of automation systems.

Syllabus:
Planning and implementation of Automation; Automated assembly; Automated materials flow and storage systems; Control theory; PID controllers; Programmable Logic Controllers (PLC's); Adaptive control in manufacturing; Hierarchical control concepts; Hardware and software process integration; Instrumentation; Maintenance and diagnosis; Integration of machine tools.

Recommended Text:

- Automation, Production Systems and Computer-integrated Manufacturing – Second Edition by Mikell P. Groover
- Automation and Computer-Integrated Manufacturing (ISBN 81-203-2074-3)

ME5125 – Manufacturing Processes: Advanced Aspects

Course Objectives:
To provide a sound knowledge of the advanced aspects of manufacturing processes and to introduce recent advances in manufacturing technology with respect to process, machinery, materials and tooling.

Learning Outcomes:
The students should be able to:

- Select appropriate manufacturing processes for polymer based products,
- Make informed decisions in die and mould design & manufacture, and
- Apply process planning techniques to improve productivity and reduce environmental impact.

Syllabus:
Polymer materials and processes: polymeric materials and their properties, material selection, economic of using polymer materials, environmental considerations in using polymers, High volume manufacturing techniques; Mould based manufacturing processes; Design and manufacture of dies and moulds; Tool materials and design; Packaging technologies; Process planning; Set-up planning .

Recommended Text:

- Processes and Materials of Manufacture – 4th Edition by Roy A Lindberg
- Materials & Processes in Manufacturing by E Paul Degarmo, JT Black, Ronal A Kohser

ME5140 - Product Design

Course Objectives:
To provide the understanding of complete product development process and impart the knowledge required for developing successful product.

Learning Outcomes:
The students should be able to:

- Use a systematic approach for product design,
- Apply ergonomic and value engineering principles in product design, and
- Use CAD and FEM software for product modelling and analysis.

Syllabus:
Design process; Need recognition; Problem Definition; Product positioning; Conceptual design; Ergonomic considerations; Material selection; Value Engineering; DFM/DFA/DFX; Design optimisation; Detailed design; Life-cycle engineering; Prototyping; Tools for product design – CAD and FEM software.

Recommended Text:

- Product Design & Development by Karl Ulrich Eppinger, McGraw-Hill, ISBN 0072471468
- Product Design And Manufacturing, Second Edition by Gupta RCISBN 81-203-2041-7

ME5141 – Special Studies

Course Objectives:
To gain the skill in doing a research project.

Learning Outcomes:
The students should be able to:

- Carryout an effective literature survey for a research, and
- Communicate research findings effectively through reports and presentations.

Syllabus:
In this course the student will be assigned a topic and he/she has to do a literature survey and write a short report on the feasibility of the project. The student has to make a seminar presentation with his findings.

Recommended Text:

- Writing a Thesis: Substance and Style by Keith Van Wagenen
- Basic Presentation Skills by Gary Kroehnert
- Effective Presentation Skills by Robert B Dilts

ME5142 – Design of Manufacturing Systems

Course Objectives:
To impart design knowledge of the aspects of manufacturing process, work organisation and manufacturing facilities.

Learning Outcomes:
The students should be able to:

- Select appropriate manufacturing process for a given requirement,
- Plan workplaces to increase the utilization of limited resources,
- Use system modelling and simulation to analyse manufacturing systems, and
- Apply work measurement techniques for effective workplace design and productivity improvement.

Syllabus:
Selection of manufacturing process; Tolerance optimisation; Economic considerations; Long term capacity planning; Factory Layout; Flow lines; Group technology; Workplace design; Assembly system; Inspection system; Material handling systems; Storage and retrieval systems; Planning for factory automation and mechanisation; System Modelling and simulation.

Job design: Behavioural and physical considerations, Work methods, Work measurement and standards, Wage and incentive plans.

Recommended Text:

- Systems Approach to Computer-Integrated Design and manufacturing by Nanua Singh
- Cellular Manufacturing Systems: Design, Planning and Control by Nanua Singh, Divakar Rajamani
- Manufacturing Systems Design and Analysis: Context and Techniques by B Wu

ME5143 – Manufacturing Strategy

Course Objectives:
To understand the nature of manufacturing competitiveness. To appreciate the procedures and methodologies for developing manufacturing strategies.

Learning Outcomes:
The students should be able to:

- Make a positive contribution in develop manufacturing strategies to Improve the competitiveness of an organization,
- Make informed decisions regarding facility location, capacity, etc., and
- Strategically manage human resources to align with the objectives of an organisation.

Syllabus:
Relation of manufacturing strategy to business strategy, financial strategy and marketing strategy; Manufacturing as a competitive weapon; Contribution of manufacturing function to overall performance; Contents of manufacturing strategy; Technology and process choice; Process positioning; Capacity and location decisions: long term capacity strategies, international capacity planning; planning facilities with a region; Global manufacturing and the virtual corporation; Focused manufacturing; Continuous improvements and the experience curve. Strategic management of human resources: strategy implementation and change management; Linking operational performance to manufacturing strategy.

Recommended Text:

- Manufacturing Strategy: Text and Cases by Terry J Hill
- Manufacturing Strategy: The Strategic Management of the Manufacturing Function by Terry Hill
- Manufacturing Strategy: How to Formulate and Implement a Winning Plan (Manufacturing & Production) by John Miltenburg
- Advanced Manufacturing: Strategy and Management by D Macbeth

ME5144 – Mechatronics and Robotics

Course Objectives: (Pre-requisite: ME5124 - Automation and Control of Manufacturing Systems)

To introduce students to the engineering and management techniques of the design and development process of a mechatronics product/system.

Learning Outcomes:
The students should be able to:

- Understand the basic signal conditions used in mechatronic systems,
- Use motors, stepper motors used in industrial applications,
- Develop mechatronic applications for the industry, and
- Understand robotic system and robotic sensory systems.

Syllabus:
Introduction of mechatronics; Revision of basic mechanics, electricity and electronics, Introduction to programming; Study of components of a mechatronics system such as stepper motors, A/D converters, Op-amps. Solid-state devices; Conceptual design of a mechatronics system; Implementation of robot systems; Robot programming; Machine vision.

Recommended Text:

- Introduction to AI Robotics by Murphy RR, Prentice-Hall, ISBN 81-203-2458-7
- Understanding Electro-Mechanical Engineering by Kamm, LJ, ISBN 81-203-1681-9
- Robotic Engineering: An Integrated Approach by Richard D Klsfter and Thomas A Chmielewski
- Introduction to Robotics: Analysis, Systems, Applications by Saeed B Niku; The Mechatronics Handbook by Robert H Bishop

ME5145 – Artificial Intelligence in Manufacturing

Course Objectives:
To gain an understanding of expert systems and AI techniques and how it can be applied in control, automation, manufacturing, design and operational management.

Learning Outcomes:
The students should be able to:

- Understand the basic concepts used in AI techniques,
- Use the AI technique in applications, and
- Understand the limitations and advantageous of using AI techniques relative to conventional methods.

Syllabus:
Knowledge based systems, Expert systems, Fuzzy systems and fuzzy control, Artificial Neural Networks, Genetic Algorithms, Selection of AI techniques, AI based applications in control, automation, manufacturing, design and operations management.

Recommended Text:

- An Introduction to Neural Network by James A. Anderson
- Introduction to Expert Systems by Peter Jackson

ME5146 – Human Factors Engineering

Course Objectives:
To gain an understanding of the impact of human capabilities and limitations on the design and development of products and equipment. To appreciate the contemporary approaches to the design of safe and fatigue free work environments.

Learning Outcomes:
The students should be able to:

- Provide work, interfaces, and facilitators that are motivating,
- Provide selection criteria that enable the best matching of user abilities, skills, and attitudes with the work,
- Optimize the basic work design, Optimize the design of critical interface, Develop effective training materials, and
- Develop meaningful and useful instruction including performance aid.

Syllabus:
The scope of human factors engineering and its relationship with product design and manufacture; Systems Ergonomics; Human characteristics; Principles of anthropometry; Application of ergonomics to product design; Biomechanics and safety engineering; Introduction to Ergonomics CAD in product design; Practical case studies taken from the fields of consumer product design, work place and work design.

Recommended Text:

- Human Performance Engineering: A Guide to System Designers by Robert W Baily
- Handbook of Human Factors by Gavriel Salvendy
- Human Factors in Engineering and Design by Mark S Sanders, Ernest J McCormick

ME5147 – Sustainable Manufacturing

<table>
<tr><td>Module Code</td><td colspan="2">ME5147</td><td>Module Title</td><td colspan="4">Sustainable Manufacturing</td></tr>
<tr><td>Credits</td><td colspan="2">3</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2.5</td><td rowspan="2">Pre - requisites</td><td rowspan="2">-</td></tr>
<tr><td>GPA/NGPA</td><td colspan="2">GPA</td><td>Lab/Assignments</td><td>1</td></tr>
<tr><td>Module Aim:</td><td colspan="7">To understand, critically evaluate, and incorporate sustainable manufacturing principles in manufacturing operations and strategies</td></tr>
<tr><td colspan="8">Learning Outcomes
After completing this module, the students should be able to:
LO-1: Explain the context and the fundamental concepts of sustainable manufacturing
LO-2: Assess the life cycle environmental and economic impacts of a given product/process
LO-3: Appraise the triple bottom line sustainability aspects of manufacturing to make informed decisions
LO-4: Adapt sustainable manufacturing concepts and practices in relevant industries/supply chains</td></tr>
<tr><td colspan="6">Module Outline</td><td colspan="2">Learning Outcomes Covered</td></tr>
<tr><td colspan="6">Section 1: Fundamentals of Sustainable Manufacturing [10 hrs]
Sustainable Development Goals; Triple Bottom Line (TBL) sustainability of manufacturing; The 6-R concept; Design for Manufacturing; Remanufacturing for sustainability; Design for Remanufacturing (DfRem); Environmentally conscious design of components; Energy- and Resource-Efficient Manufacturing; Sustainable manufacturing technologies; Reuse and recycling; International Regulations for green design and manufacturing</td><td colspan="2">LO-1</td></tr>
<tr><td colspan="6">Section 2: Life Cycle Assessment and Life Cycle Costing [10 hrs]
ISO 14001/14040/14044: Environment Management Standards; Fundamentals of the Life Cycle Sustainability Assessment (LCSA) Process, Applications of LCSA and available software; Product LCA vs Process LCA, Inventory development and Impact assessment, Interpretation and reporting of LCA results; Life cycle costing for products and processes</td><td colspan="2">LO-1
LO-2
LO-3</td></tr>
<tr><td colspan="6">Section 3: Strategies to implement sustainable manufacturing [10 Hrs]
Evidence-based scientific decision making for sustainable manufacturing; Quality function deployment in product/process design; Goal definition and key performance indicators; Stakeholder priorities and weighting; Multicriteria decision making techniques for product/process design</td><td colspan="2">LO-2
LO-3</td></tr>
<tr><td colspan="6">Section 4: Sustainable supply chain development [5 Hrs]
Sustainable supply chains; Supplier performance assessment; Stakeholder management; Opportunities and challenges for sustainability integration in supply chains; Impact of regulations and policies</td><td colspan="2">LO-3
LO-4</td></tr>
<tr><td rowspan="4">Assessments</td><td>Category</td><td colspan="3">Type</td><td>Assessed LOs</td><td>Weightage (%)</td></tr>
<tr><td rowspan="2">CA</td><td colspan="3">Project: LCSA of a product [30%]</td><td>LO-2, LO-3</td><td rowspan="2">40 %</td></tr>
<tr><td colspan="3">Journal paper assignment [10%]</td><td>LO-2, LO-3, LO-4</td></tr>
<tr><td>WE</td><td colspan="3">End Semester Examination</td><td>All</td><td>60 %</td></tr>
<tr><td colspan="8">Recommended Texts:
1. Goedkoop, M., Oele, M., Leijting, J., Ponsioen, T., Meijer, E. (2016). Introduction to LCA with SimaPro. San Francisco.
2. Gupta, K., & Salonitis, K. (Eds.). (2021). Sustainable Manufacturing (1st Editio). Elsevier. https://doi.org/10.1016/C2018-0-00912-3
3. Stark, R., Seliger, G., & Bonvoisin, J. (Eds.). (2017). Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives. Springer International Publishing. https://doi.org/10.1007/978-3-319-48514-0</td></tr>
</table>

4. International Organization for Standardization. (2006). *ISO 14040: Environmental management--Life cycle assessment - Principles and framework*. International Organization for Standardization.
5. Vinodh, S. (2020). *Sustainable Manufacturing* (First edit). CRC Press. https://doi.org/10.1201/9780429320842

Remarks:

4 Performance Criteria

4.1 PG Diploma in Manufacturing Systems Engineering

4.1.1 Title of Award:

Postgraduate Diploma in Manufacturing Systems Engineering

4.1.2 Participation in Academic Programme:

1. The candidate is required to have attended at least 80% in lectures, tutorial classes, seminars and other components.
2. Undertake an individual (preliminary) project, as assigned by the department, on a specific subject area.
3. No postponement of the course or course modules is allowed without the prior approval of the senate

4.1.3 Pass in the Postgraduate Examination:

1. A candidate is deemed to have passed the Postgraduate Examination if the candidate has:
   a. Successfully completed the required course units, including compulsories, totalling a minimum of **40 credits**;

AND

   b. Successfully completed the prescribed seminars;

AND

   c. Successfully completed all the prescribed assignments, laboratory work;

AND

   d. Successfully completed all the prescribed project / research component.

Note: In order to be considered successful and earn credit for the course unit, the candidate must earn grade C or above. Where a course unit consists of more than one component (written examination, seminars, laboratory work, assignments etc.) the pass mark for each component is 40%.

2. If the candidate is unsuccessful in any of the parts 1(a) through 1(d), he/she may be re-examined. Normally only one re-examination will be allowed and this shall be at the next holding of the examinations or assessments. No postponement shall be allowed without approval from the Senate.
3. Classes will not be awarded.

4.1.4 Credit Rating:

A credit is defined as one hour of lectures per week for the duration of one term which will usually be of 14 weeks duration. A credit will also be equivalent to 2 hours of assignments, tutorials, practical work, etc. or equivalent per week for one term.

4.1.5 Grading of Marks:

Performance of the candidate in each course unit shall be graded based on the following benchmarks (see the table):

Grade	Benchmark	Grade Point	Description
A+	>= 85%	4.2	
A	75% - 85%	4.0	Excellent
A-	70% - 74%	3.7	
B+	65% - 69%	3.3	
B	60% -64%	3.0	Good
B-	55% - 59%	2.7	
C+	50% - 54%	2.3	Pass
C+	Above 50%	2.0	Pass (Repeat Candidate)
I		0	Incomplete
F		0	Fail
N		0	Academic Concession

A candidate who has not earned a grade of C+ or above in a particular course unit at the first attempt, but has obtained minimum marks for at least one component, receives the grade I; otherwise he receives the grade F. By repeating the incomplete component for those obtaining the grade I, or all the components for those obtaining the grade F, the candidate can upgrade to grade C+ only and this will be used for calculating the grade point average (GPA). The grade N signifies the academic concession granted with the approval of the Senate.

4.1.6 Calculation of Grade Point Average:

The overall grade point average (GPA) of the postgraduate examination will be calculated according to the following formula.

$$Overall\ GPA = \frac{\sum(Grade\ Points\ \mathrm{X}\ Credits)}{\sum Credits}$$

Note: All credits offered by the student, irrespective of whether completed or not will be considered in the evaluation of the Overall GPA.

4.1.7 Release of Result of Written Examination:

Performance of a candidate at the written examination shall be released after the Board of Examiners meeting, subject to confirmation of the Senate, unless the Board of Examiners recommends withholding of the results for specific reasons.

4.1.8 Criteria for the Award of the Postgraduate Diploma:

1. Passed the Postgraduate Examination as specified in clause 4.1.3

AND

2. Not desirous of proceeding to the Master's dissertation, either before commencement or thereafter, as indicated in writing to the Head of Department OR Not able to undertake/complete the Master's dissertation under the prescribed conditions.

4.1.9 Date of Award:

The effective date of the Postgraduate Diploma shall be the last day of the month of the successful completion of all of the following components of the postgraduate examination:

1. Written examinations
2. Seminars
3. Assignments
4. Laboratory work and projects

4.2 M.Eng in Manufacturing Systems Engineering

4.2.1 Title of Award:

Master of Engineering in Manufacturing Systems Engineering

4.2.2 Participation in Academic Programme:

1. Passed the postgraduate examination as specified in clause 4.1.3 but has not been awarded the Postgraduate Diploma.
2. Undertake an individual research project, as assigned by the Department, on a specific subject area, for a period of not less than one academic year duration on a part time basis or equivalent.
3. The postponement of the dissertation will only be allowed with prior approval from the Senate.

4.2.3 Pass in the Dissertation:

1. The research Project will be evaluated based on the evaluation of the final seminar and oral examination by a panel of examiners. The grading for the research project is Pass/Fail.
2. If the candidate is unsuccessful in dissertation, he/she may be re-examined and given the pass minimum of three months but not exceeding 12 months after the initial examination/assessment.

4.2.4 Criteria for the Award of the MEng Degree:

1. Successful completion of the Postgraduate Examination as specified in clause 4.1.3 WITH overall GPA not less than 2.5;

AND

2. Successfully completed any additional prescribed seminars and assignments;

AND

3. Successfully completed the research dissertation assigned to the candidate.

4.2.5 Date of Award:

The effective date of the MEng degree shall be the first day of the following month after the successful completion and evaluation of all of the following components:

1. Postgraduate Examination as specified in clause 4.13
2. Research dissertation
3. Submission of final bound copies of dissertation (after corrections, if any)

5 Resource Persons

Course Coordinator	
Dr. J.R. Gamage Senior Lecturer Dept. of Mechanical Eng., University of Moratuwa	0112-650301 ext. 4531 gamagejr@uom.lk
Lecturers	
Dr. H.K.G. Punchihewa Head/ Senior Lecturer Dept. of Mechanical Eng., University of Moratuwa	himank@uom.lk
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Prof. M.A.R.V. Fernando Visiting Lecturer Dept. of Mechanical Eng., University of Moratuwa	marv.fernando@gmail.com
Dr. Manoj Ranaweera Senior Lecturer Dept. of Mechanical Eng., University of Moratuwa	manoj@uom.lk
Dr. A.G.B.P. Jayasekara Professor Dept. of Electrical Eng., University of Moratuwa	buddhikaj@uom.lk
Mr. Pubudu Ranaweera Senior Lecturer Dept. of Mechanical Eng., University of Moratuwa	pubudur@uom.lk
Mr. Janaka Mangala Lecturer Dept. of Mechanical Eng., University of Moratuwa	janaka@uom.lk
Mr. D.D. Ananda Gamini Senior Lecturer Dept. of Statistics and Computer Science, University of Sri Jayawardanapura	gamini@sjp.ac.lk
Mr. A. C. Mohamed Naeem Director Kingslake Engineering Systems (Pvt) Ptd., No.30, Temple lane, Colombo 03	acmnaeem@gmail.com
Dr. Dinesh Samarasinghe Senior Lecturer Faculty of Business, Uni. of Moratuwa	dineshs@uom.lk
Dr. Thilina Lalitharatne Postdoctoral Researcher, Dyson School of Design Engineering Imperial College London, United Kingdom.	t.lalitharatne@imperial.ac.uk
Dr. I. Mahakalanda Senior Lecturer Faculty of Business, Uni. of Moratuwa	indram@uom.lk
Dr. Thesara Jayawardane Senior Lecturer Faculty of Business, University of Moratuwa	thesaraj@uom.lk
Mr. Suneth Kotutenne Associate Director Manufacturing Ansell	sundevkot@yahoo.com

6 Course Fees

Tuition Fees* :	PG Diploma	- Rs. 300,000/=
	M.Eng. (an additional)	- Rs. 100,000/=
	Rs. 50,000 for an additional year (up to the maximum duration of programme)	
Other Fees :	Registration Fee (First year)	- Rs. 2,000/=
	Registration Fee (Second Year)	- Rs. 2,000/=
	Examination Fee	- Rs. 500/= per year
	Re-examination Fee- Registration	- Rs. 500/=
	(Additional Rs. 100/= per subject)	
Library Deposit:	Standard Deposit	- Rs. 2,500/= per book, up to **6 books**
	Deposit with guarantee	- Rs. 7,500/= for 6 books
	Concessionary Deposit	- Rs. 2,500/= for 2 books

Note: Tuition fees and other fees **will not be refunded** in any case.

*** Note:** Tuition fee for International students (Non-Sri Lankan) is the local fee plus an **additional USD 1,250** (or equivalent in LKR terms) to be paid in advance with the first installment/full payment.

Remarks

Although some modules have not explicitly mentioned any prerequisites from this course, most postgraduate modules inevitably require students to demonstrate undergraduate-level knowledge/ experience. Therefore, it is the responsibility of the student to refresh/ advance their knowledge to a level sufficient to grasp the contents of each module. The lecturer is not responsible to update or refresh a student's knowledge before approaching the content of his/her module. However, if you inquire the lecturer well in advance he/ she may, at his/her sole discretion, direct you to acquire the necessary background knowledge.

Wisdom is all wealth