MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

ME527 INTRODUCTION TO ENGINEERING OPTIMISATION

Module Registrar: Dr E Minisci edmondo.minisci@strath.ac.uk	**Taught To (Course): Cohorts for whom class is optional**	
Other Lecturers Involved:	**Credit Weighting: 10**	**Semester: 2**
Optional class	**Academic Level: 5**	**Suitable for Exchange: Y**

Required prerequisites

Note: It is the responsibility of ALL students to ensure that they satisfy the prerequisite knowledge for this module BEFORE adding as part of curriculum selection. If unsure, please contact the Module Registrar or discuss with your Programme/Year Adviser of Studies.

Good programming skills:
Knowledge of basic programming principles:
- manipulation of scalar, vectors and matrices variables;
- use of operators, expressions and statements (including conditional statements);
- algorithms, structured programming logic and flow diagrams;
- computer arithmetic and errors.

Ability to construct flow charts to summarise key steps of a problem.

Ability to develop and implement effective algorithms (MATLAB is the officially supported language/environment for this module, but the assignments and courseworks can be done in any programming language).

Mathematical methods:
Linear algebra, vectors & matrices.

Numerical Methods:
Solution of linear and nonlinear equations; differentiation and integration; numerical quadrature; interpolation.

Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
12	26						10	52	100

Educational Aim

This module aims to provide an introduction to optimization techniques for continuous problems and to the approaches to formulate and solve optimization problems in engineering. Using a combination of lectures, computer lab tutorials, and assignments, students will develop an understanding of the overall design optimisation process and the performance of different optimisation algorithms, when applied to solve real engineering design problems.

Learning Outcomes

On completion of the module the student is expected to be able to:

LO1 Understand basic theoretical principles of optimization

LO2 Learn and implement, in a computer environment, different optimisation algorithms and assess their performance (effectiveness and efficiency)

LO3 Formulate engineering design problems as mathematical optimization problems.

LO4 Solve engineering optimisation problems through the use of available optimisation tools and self-developed ones.

Syllabus

The module will teach the following:

- Introduction
  - Description of the optimisation process, and overview of real problems
  - Brief classification of problems and optimisation algorithms
  - Problem formulations
    - Unconstrained/Constrained problems
    - Single objective / Multi-objective problems
- Optimisation algorithms and applications
  - Optimisation theory
  - Local optimisation and related software libraries
    - Derivative free algorithms to solve unconstrained and constrained problems
    - Derivative based algorithms to solve unconstrained and constrained problems
    - Multi-objective formulations
  - Global optimisation and related software libraries
    - Stochastic algorithms to solve unconstrained and constrained problems
    - Multi-objective formulations
- Approaches to handle expensive numerical models
  - Design of Experiments
  - Surrogate modelling approaches
  - Surrogate based optimisation approaches

Assessment of Learning Outcomes

Criteria

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning:

LO1
C1 The ability to understand and describe how a general optimisation process works.
C2 The ability to describe the possible main features of the optimisation problems.

LO2
C1 The ability to describe/implement the main characteristics/steps of mostly used optimisation algorithms.
C2 The ability to choose the best suited optimisation algorithm on the basis of the known features of the problem.

LO3
C1 The ability to understand main features of real design optimisation problems and convert them to the most convenient mathematical formulation.

LO4
C1 Students should know the most used optimisation libraries and should be able to apply and adapt them to solve cases of interest.

The standards set for each criterion per Module Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessment.

Principles of Assessment and Feedback
(within Assessment and Feedback Policy at: https://www.strath.ac.uk/professionalservices/staff/policies/academic/)

Regular feedback and discussion will be available in tutorial sessions.

Individual feedback will be available by appointment with the course lecturer.

Formal, summative feedback will be provided by the return of Myplace time constrained quizzes marks to students. Individual feedback on the Myplace quizzes may be arranged, via drop-in sessions or single appointments.

Discussion of the course material between teacher-student and also amongst peers will be encouraged in tutorial sessions. Students will also be encouraged to discuss the coursework with their peers to improve learning.

The coursework and the assignments will be returned with marks and written feedback to allow students to reflect on their performance. Coursework and assignments results will be discussed as soon as possible (date and time will be agreed to meet and review the submissions and the feedbacks).

Assessment Method(s) Including Percentage Breakdown and Duration of Exams *(individual weightings)*

Examination				Coursework		Practical		Project	
Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***	Number	***Weighting***
2	February & March (Myplace quizzes)	30 mins each	30% (15% each)	1	40%	2 Comp Lab assign ments	30% (15% each)		
LO1-LO4				LO1-LO4		LO1-LO4		*	

L/Os: *Indicate which Learning Outcomes (L01, L02, etc) are to be assessed by exam/coursework/practical/project as required.*

Coursework / Submission deadlines (*academic weeks*):
Two online, time constrained quizzes – submission in weeks 4 and 7.
Coursework 1: submission Monday of week 11
Practical: Computer Lab assignment 1 – submission week 5
Practical: Computer Lab assignment 2 – submission week 8

Resit Assessment Procedures:
Submission of alternate ^^coursework prior to commencement of the July/August exam diet.

^^Students must contact the module Registrar for details as soon as results confirm that a resit is required.

PLEASE NOTE:
Students must gain a summative mark of 50% to pass the module. Students who fail the module at the first attempt will be re-assessed prior to the July/August exam diet. This re-assessment will consist entirely of a coursework. No marks from any previous attempts will be transferred to a new resit attempt.

Recommended Reading

*****Purchase recommended **Highly recommended reading *For reference**

A reading list of recommended texts is issued at the start of the class. No single text is used. Comprehensive lecture slides are provided

Additional Student Feedback
(Please specify details of when additional feedback will be provided)

Date	Time	Room No
Weekly	To be agreed	Check timetable webpages for details

Session: 2024/25

Approved:

Programme Lead/Director Signature: Dr A McLaren

Date of Last Modifications: 23/08/2024

(MAE template updated July 2024)

MODULE TIMETABLE

Module Code:	**ME527**	**Module Title:**	**Introduction to Engineering Optimisation**

Brief Description of Assessment:

Assessment will be conducted through:
- two online, time constrained quizzes counting as 30% of the final mark (15% for each quiz),
- a coursework counting as 40% of the final mark, and
- two lab/programming assignments counting as 30% (15% for each assignment).

Note that all assessments will be completed before the April/May exam period.

Assessment Timing

Indicated on the table below are the start/submission dates for each assignment/project and the timing of each exam/assessment.

Please note: Timings could change during unforeseen periods of disruption; this should only be used as a guide.

Semester One	W&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item.

Semester Two	C&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Online Test	Lab Report Submission	Choose an item. Choose an item.	Online Test Coursework Set	Lab Report Submission	Choose an item. Choose an item.	Choose an item. Choose an item.	Coursework Submit	Choose an item.