Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

POSTGRADUATE TAUGHT STUDENT HANDBOOK

MSC (FHEQ LEVEL 7)

MSc COMPUTATIONAL ENGINEERING DEGREE PROGRAMME

SUBJECT SPECIFIC
PART TWO OF TWO
MODULE AND COURSE STRUCTURE
2023-24

DISCLAIMER

The Faculty of Science and Engineering has made all reasonable efforts to ensure that the information contained within this publication is accurate and up-to-date when published but can accept no responsibility for any errors or omissions.

The Faculty of Science and Engineering reserves the right to revise, alter or discontinue degree programmes or modules and to amend regulations and procedures at any time, but every effort will be made to notify interested parties.

It should be noted that not every module listed in this handbook may be available every year, and changes may be made to the details of the modules. You are advised to contact the Faculty of Science and Engineering directly if you require further information.

The 23-24 academic year begins on 25 September 2023

Full term dates can be found here

DATES OF 23-24 TERMS

25 September 2023 – 15 December 2023

8 January 2024 – 22 March 2024

15 April 2024 – 07 June 2024

SEMESTER 1

25 September 2023 – 29 January 2024

SEMESTER 2

29 January 2024 – 07 June 2024

SUMMER

10 June 2024 – 20 September 2024

IMPORTANT

Swansea University and the Faculty of Science of Engineering takes any form of **academic misconduct** very seriously. In order to maintain academic integrity and ensure that the quality of an Award from Swansea University is not diminished, it is important to ensure that all students are judged on their ability. No student should have an unfair advantage over another as a result of academic misconduct - whether this is in the form of **Plagiarism**, **Collusion** or **Commissioning**.

It is important that you are aware of the **guidelines** governing Academic Misconduct within the University/Faculty of Science and Engineering and the possible implications. The Faculty of Science and Engineering will not take intent into consideration and in relation to an allegation of academic misconduct - there can be no defence that the offence was committed unintentionally or accidentally.

Please ensure that you read the University webpages covering the topic – procedural guidance here and further information here. You should also read the Faculty Part One handbook fully, in particular the pages that concern Academic Misconduct/Academic Integrity.

Welcome to the Faculty of Science and Engineering!

Whether you are a new or a returning student, we could not be happier to be on this journey with you.

At Swansea University and in the Faculty of Science and Engineering, we believe in working in partnership with students. We work hard to break down barriers and value the contribution of everyone.

Our goal is an inclusive community where everyone is respected, and everyone's contributions are valued. Always feel free to talk to academic, technical and administrative staff, administrators - I'm sure you will find many friendly helping hands ready to assist you. And make the most of living and working alongside your fellow students.

During your time with us, please learn, create, collaborate, and most of all – enjoy yourself!

Professor David Smith
Pro-Vice-Chancellor and Executive Dean
Faculty of Science and Engineering

Faculty of Science and Engineering	
Pro-Vice-Chancellor and Executive Dean	Professor David Smith
Director of Faculty Operations	Mrs Ruth Bunting
Associate Dean – Student Learning and Experience (SLE)	Professor Laura Roberts
School of Aerospace, Civil, Electrical, General and Mechanical Engineering	
Head of School	Professor Antonio Gil
School Education Lead	Professor Cris Arnold
Head of Civil Engineering	Professor Eduardo De Souza Neto
Civil Engineering Programme Director	Dr Clare Wood
Year Coordinators	Professor Rubén Sevilla

STUDENT SUPPORT

The Faculty of Science and Engineering has two **Reception** areas - Engineering Central (Bay Campus) and Wallace 223c (Singleton Park Campus).

Standard Reception opening hours are Monday-Friday 8.30am-4pm.

The **Student Support Team** provides dedicated and professional support to all students in the Faculty of Science and Engineering. Should you require assistance, have any questions, be unsure what to do or are experiencing difficulties with your studies or in your personal life, our team can offer direct help and advice, plus signpost you to further sources of support within the University. There are lots of ways to get information and contact the team:

Email: studentsupport-scienceengineering@swansea.ac.uk (Monday–Friday, 9am–5pm)

Call: +44 (0) 1792 295514 (Monday-Friday, 10am–12pm, 2–4pm).

Zoom: By appointment. Students can email, and if appropriate we will share a link to our Zoom calendar for students to select a date/time to meet.

The current student **webpages** also contain useful information and links to other resources:

https://myuni.swansea.ac.uk/fse/

READING LISTS

Reading lists for each module are available on the course Canvas page and are also accessible via http://ifindreading.swan.ac.uk/. We've removed reading lists from the 23-24 handbooks to ensure that you have access to the most up-to-date versions.
We do not expect you to purchase textbooks, unless it is a specified key text for the course.

THE DIFFERENCE BETWEEN COMPULSORY AND CORE MODULES

Compulsory modules must be **pursued** by a student.

Core modules must not only be **pursued**, but also **passed** before a student can proceed to the next level of study or qualify for an award. Failures in core modules must be redeemed.

Further information can be found under "Modular Terminology" on the following link - https://myuni.swansea.ac.uk/academic-life/academic-regulations/taught-guidance/essential-info-taught-students/your-programme-explained/

MSc (FHEQ Level 7) 2023/24
Computational Engineering
MSc Computational Engineering

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
EG-M23 **Finite Element Computational Analysis** **10 Credits** **Prof R Sevilla** **CORE**	**CSCM37** **Data Visualisation** **15 Credits** **Dr B Mora/Dr JF Maestre Avila** **CORE**
EGIM02 **Advanced Computational Methods for Engineers** **10 Credits** **Dr F Zhao** **CORE**	**EG-M190** **Social, environmental and economic context of research** **10 Credits** **Dr SA Rolland/Prof JC Arnold** **CORE**
Dissertation	
EG-D04 **MSc Dissertation - Civil and Computational Engineering** **60 Credits** **Prof Y Feng** **CORE**	
Total 180 Credits	

Optional Modules
Choose exactly 75 credits

CSCM35	Big Data and Data Mining	Dr S Yang	TB2	15 (CORE)
EG-M126	Development of Virtual Reality Environments 1	Mr S Vowles/Mr EL Thomas	TB1	30 (CORE)
EG-M192	Research Case Study	Prof Y Feng	TB2	10 (CORE)
EG-M83	Simulation Based Product Design	Dr AJ Williams/Dr B Morgan	TB2	10 (CORE)
EGIM03	Solid Mechanics	Prof D Peric	TB1	10 (CORE)

Or
Choose exactly 75 credits

CSCM35	Big Data and Data Mining	Dr S Yang	TB2	15 (CORE)
CSCM45	Big Data and Machine Learning	Dr Z Li	TB1	15 (CORE)
CSCM72	Optimisation	Dr AAM Rahat	TB1	15 (CORE)
EG-M192	Research Case Study	Prof Y Feng	TB2	10 (CORE)
EG-M83	Simulation Based Product Design	Dr AJ Williams/Dr B Morgan	TB2	10 (CORE)
EGIM07	Dynamics and Earthquake Analysis of Structures	Prof Y Feng	TB1	10 (CORE)

Or
Choose exactly 75 credits

CSCM45	Big Data and Machine Learning	Dr Z Li	TB1	15 (CORE)
EG-M07	Optimisation	Prof C Giannetti	TB2	10 (CORE)
EG-M325	Extended Research Case Study	Prof R Sevilla/ Refer To Dept	TB1+2	20 (CORE)
EGIM03	Solid Mechanics	Prof D Peric	TB1	10 (CORE)
EGIM06	Computational Fluid Dynamics	Prof P Nithiarasu	TB2	10 (CORE)
EGIM08	Plasticity in Structural and Geotechnical Engineering	Prof D Peric	TB2	10 (CORE)

CSCM35 Big Data and Data Mining

Credits: 15 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr S Yang

Format: 20 hours lectures, 10 hours lab

Delivery Method: Primarily on campus

Module Aims: This module introduces students to the fundamental topics of data mining, including data pre-processing techniques, applied probability and statistics, data mining algorithms (incl. associate rule, classification, clustering, outlier detection and probabilistic graphical model), and big data frameworks.

Module Content: Basic knowledge in machine learning and mathematics are required, where we students are strongly encouraged to take CSCM45 and CSCM70 in the first semester. For those who have not taken those two modules, we will revisit some key concepts in the first three weeks, i.e. probability and statistics. Practical work will be done through the medium level of Python programming. You will also get to discover key scientific libraries of Python, i.e. NumPy, SciPy, Scikit-Learn, Matplotlib, Tensorflow, Hadoop, Spark. Classes in the first 3 weeks will include support time for Python programming and the use of these libraries.

Course Overview and Python Programming for Data Science
Mathematics Background: Numerical Analysis, Applied Probability and Statistics
Frequent Pattern, Association, Correlations
Naïve Bayes Classifier, Quantitative Evaluation
Decision Tree, Random Forest, AdaBoost
Maximum Likelihood Estimation, Expectation Maximisation
Clustering, DBSCAN, High Dimensional Data Analysis
Text Data Analysis, Word2Vec, Skip-Through, CBOW
Time-Series Data Analysis, Regression, Hidden Markov Model
Scalability and Efficiency Big Data Analysis

Intended Learning Outcomes: After completing this module students will:
- be able to manipulate complex, large, heterogeneous datasets, from storage to processing
- be able to extract information from complex, large, heterogeneous datasets
- be able to critically evaluate and select data mining algorithms and techniques, and be able to apply them in real world applications.

Assessment:	Coursework 1 (15%) Coursework 2 (15%) Examination (70%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Coursework 1 (February): Examination of Python programming in Data Science
Coursework 2 (March): Examination of Data Mining and Machine Learning algorithm
Exam (May/June): Standard Format Computer Science Exam

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: Grades, individual and collective written feedback for coursework.

Failure Redemption: Redemption of failure via resit instrument.

Reading List: Koller, Daphne., Friedman, Nir., Probabilistic graphical models : principles and techniques, MIT Press, 2009.ISBN: 9780262013192
Pang-Ning Tan author., Michael Steinbach author.; Anuj Karpatne author.; Vipin Kumar 1956- author., Introduction to data mining / Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar., Harlow : Pearson Education Limited, 2019.ISBN: 9780273769224
Tan, Pang-Nin; Steinbach, Michael; Kumar, Vipin, Introduction to data mining / Pang-NingTan, Michael Steinbach and Vipin Kumar., 2014.ISBN: 9781292026152
Jiawei Han author., Micheline Kamber author.; Jian Pei author., Data mining : concepts and techniques / Jiawei Han, Micheline Kamber, Jian Pei., Waltham, MA : Morgan Kaufmann Publishers is an imprint of Elsevier, 2012.ISBN: 9780123814791
I. H. Witten (Ian H.), author., Eibe Frank author.; Mark A Hall (Mark Andrew), author.; Christopher J. Pal author., Data mining : practical machine learning tools and techniques / Ian H. Witten, Eibe Frank, Mark A. Hall, Christopher J. Pal., Cambridge, MA : Morgan Kaufmann is an imprint of Elsevier, 2017.ISBN: 9780128042915
Charu C. Aggarwal author., Data mining : the textbook / Charu C. Aggarwal., Cham Switzerland ; New York : Springer, 2016.ISBN: 9783319381169
D. J. Hand (David J.), 1950- author., Heikki Mannila author.; Padhraic Smyth author., Principles of data mining / David Hand, Heikki Mannila, Padhraic Smyth., Cambridge, MA : The MIT Press, 2001.ISBN: 9780262082907
Trevor Hastie author., Robert Tibshirani author.; J. H Friedman (Jerome H.), author., The elements of statistical learning : data mining, inference, and prediction / Trevor Hastie, Robert Tibshirani, Jerome Friedman., New York, NY : Springer, 2009.ISBN: 9780387848570
Bishop, Christopher M, Pattern recognition and machine learning / Christopher M. Bishop., Springer, 2006.ISBN: 9780387310732
Gilbert Strang author., Introduction to linear algebra / Gilbert Strang., Wellesley, MA : Cambridge Press, 2016.ISBN: 9780980232776
Sheldon Jay. Axler, Linear algebra done right / Sheldon Axler., Springer, 2001.ISBN: 0387982582
Morris Herman. DeGroot, Probability and statistics / Morris H. DeGroot., Addison-Wesley, 1975.
Richard A. Johnson (Richard Arnold), 1937-, Dean W Wichern, Applied multivariate statistical analysis / Richard A. Johnson, Dean W. Wichern., Prentice-Hall, 1982.

Additional Notes: Available to visiting and exchange students. Basic knowledge in machine learning and mathematics are required and Computer Science students are strongly encouraged to take CSCM45 and CSCM70 in the first semester. For those who have not taken those two modules, some key concepts will be revisited in the first three weeks, i.e. probability and statistics. NOTE: students on the MSc Applied Data Science will have covered the relevant material in MA-M06 and MA-M16

CSCM37 Data Visualisation

Credits: 15 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr B Mora, Dr JF Maestre Avila

Format: 20 hours lectures,
10 hours practicals

Delivery Method: On-campus and lab sessions.

Module Aims: Data Visualisation is concerned with the automatic or semi-automatic generation of digital images that depict data in a meaningful way(s). It is a relatively new field of computer science that is rapidly evolving and expanding. It is also very application oriented, i.e., real tools are built in order to help scientists from other disciplines.

Module Content: Introductory topics include: purposes and goals of visualisation, applications, challenges, the visualisation pipeline, sources of data: data dimensionality, data types, and grid types.

Information visualisation topics include: abstract data, hierarchical data, tree maps, cone trees, focus and context techniques, hyperbolic trees graphs and graph layouts, multi-dimensional data, scatter plots, scatter plot matrices, icons, parallel coordinates, interaction techniques, linking and brushing.

Volume visualisation topics include: slicing, surface vs. volume rendering, transfer functions, interpolation schemes, direct volume visualisation, ray casting, shear-warp factorisation, image order vs. object order algorithms, gradients, filtering, interpolation, and isosurfacing.

Flow visualisation topics include: simulation, measured, and analytical data, steady and time-dependent (unsteady) flow, direct and indirect flow visualisation, applications, hedgehog plots, vector glyphs, numerical integration schemes, streamlines, streamline placement, geometric flow visualisation techniques, line integral convolution (LIC), texture-based techniques, feature-based flow visualisation.

Intended Learning Outcomes: Students will be able to:
- identify problems that can be addressed with visualisation.
- comprehensively explain data visualisation techniques and be able to critically appraise their suitability to particular situations.
- choose, evaluate and apply visualisation techniques to effectively reveal insights into complex and potentially-incomplete data.

Assessment: Examination 1 (60%)
Coursework 1 (20%)
Coursework 2 (20%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Standard Computer Science format unseen examination, duration 2hrs.
Two practical courseworks.

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: Outline solutions provided along with group and individual analytical feedback for courseworks.
Examination feedback summarising strengths and weaknesses of the class.

Failure Redemption: Resit examination and/or resubmit coursework(s) as appropriate.

Reading List: Matthew Ward 1955-, Georges G Grinstein; Daniel Keim, Interactive data visualization : foundations, techniques, and applications / Matthew Ward, Georges Grinstein, Daniel Keim., Boca Raaton : CRC Press, Taylor & Francis Group, 2015.ISBN: 9781482257373

Additional Notes: Available to visiting and exchange students.

CSCM45 Big Data and Machine Learning

Credits: 15 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr Z Li

Format: 20 hours lectures, 10 hours lab.

Delivery Method: On campus lectures.

Module Aims: This module will discuss in-depth some of the most widely used and state-of-the-art artificical intelligence and machine learning techniques and their applications to big data problems. The students will gain both theoretical understanding of learning and practical know-how in applying those theories to real world problems. Topics include big data concept, data mining, learning theories, supervised and unsupervised learning, and reinforcement learning.

Module Content: This module covers three parts: introduction to big data and learning, data analysis techniques, and learning concepts and methods.

Introduction to big data and data mining;
Data clustering;
Dimensionality reduction: linear techniques;
Dimensionality reduction: nonlinear techniques;
Discriminative analysis;
Learning theory, including bias and variance theory, innovation process in machine learning;
Expert systems;
Unsupervised learning;
Supervised learning, including parametric and nonparametric methods, neural network, kernels, support vector machine, randomised decision trees;
Reinforcement and adaptive control;
Example applications to bioinformatics, health informatics, and web data processing.

Intended Learning Outcomes: Upon completion of this module students will be able to:
- Describe, explain, and critique the fundamental techniques of analysing complex and heterogeneous data.
- Describe and explain machine learning techniques and their applications to big data problems.
- Discuss and contrast both conventional and state-of-the-art machine learning techniques.
- Implement and apply machine learning techniques to synthesise solutions.
- Analyse big data problems and evaluate and devise potential solutions.

Assessment:	Examination 1 (60%) Coursework 1 (20%) Laboratory work (20%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Standard format Computer Science exam.
Essay-based practical programming assignment.
Laboratory work with quizzes.

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: Outline solutions provided along with analytical individual feedback for assignment. Examination feedback summarising strengths and weaknesses of the class.

Failure Redemption: Redemption of failure via resit instrument.

Reading List: Christopher M. Bishop, Pattern recognition and machine learning / Christopher M. Bishop., Springer, 2006.ISBN: 9780387310732
Mehryar. Mohri, Afshin Rostamizadeh; Ameet Talwalkar, Foundations of machine learning Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar., MIT Press, 2012.ISBN: 0262305666
Rajaraman, Anand., Ullman, Jeffrey D.,, Mining of massive datasets / Anand Rajaraman, Jeffrey David Ullman., Cambridge University Press,, 2012.ISBN: 9781107015357
Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin, Learning From Data, AMLBook, 2012.ISBN: 1600490069
David L. Poole (David Lynton), 1958-, Alan K Mackworth, Artificial intelligence: foundations of computational agents / David L. Poole, Alan K. Mackworth., Cambridge University Press, 2010.ISBN: 9780521519007

Additional Notes: Available to visiting and exchange students.

CSCM72 Optimisation

Credits: 15 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr AAM Rahat

Format: 30 hours (20 lectures, 10 laboratory hours)

Delivery Method: On Campus Lectures and Labs.

Module Aims: Optimisation is at the core of many disciplines. Whether we want to improve the performance of a machine learning model,
increase the efficiency of an aircraft design, or simply reduce the costs of productions in a business operation, we must
deploy computational optimisation methods for achieving the best results. In this module, we will cover mathematical and
algorithmic fundamentals of optimisation, including derivative and derivative-free approaches for both linear and non-linear
problems. We will also discuss advanced topics, such as multi-objective optimisation, handling uncertainty, principled methods when problem evaluations are computationally expensive, and performance comparison between stochastic optimisers, in the context of real-world problems.

Module Content: * Introduction to optimisation.
* Derivatives and related gradient descent methods.
* Stochastic and evolutionary methods.
* Constrained optimisation problems.
* Multi-objective optimisation and decision-making.
* Model-based methods.
* Performance comparison for stochastic optimisers.
The labs will programmatically explore optimisation problems and algorithms.

Intended Learning Outcomes: On completion of this module, students will be able to:
* Demonstrate systematic understanding of fundamental concepts of optimisation problems and algorithms.
* Analyse an unseen optimisation problem, and formulate a mathematical description.
* Propose an appropriate method to solve an optimisation problem, and justify their selection.
* Develop appropriate software for solving optimisation problems.
* Critically evaluate performance of multiple competing optimisers, and communicate analysis to specialist and nonspecialist
audiences
* Critically review a relevant topic from the literature.

Assessment:	Examination (60%)
	Coursework 1 (20%)
	Report (20%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination. Standard unseen 2 hour Computer Science examination.
Coursework. A practical programming assignment on solving an optimisation problem.
Report. A short critical review on a relevant topic from the literature. [1000-1200 words]
Quiz. A range of multiple choice questions. [Non assessed]

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: Individual feedback on coursework and report..

Failure Redemption: 100% Examination Resit Instrument.

Reading List: Mykel J. Kochenderfer and Tim A. Wheeler, Algorithms for Optimization, MIT Press, March 2019.ISBN: 9780262039420
Allen Downey, Think Python, 2015.
Singiresu S. Rao, Engineering Optimization: Theory and Practice, Wiley, December 2019.ISBN: 978-1-119-45471-7
Xin-She Yang, Introduction to Mathematical Optimization: From Linear Programming to Metaheuristics, Cambridge International Science Publishing, 2008.ISBN: 9781904602828

Additional Notes:

Available for visiting and exchange students.

EG-D04 MSc Dissertation - Civil and Computational Engineering

Credits: 60 Session: 2023/24 June-September

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof Y Feng

Format: Typically 1 hour per week i.e 10-15 hrs total contact time. Each student is to be supervised in accordance with the University's Policy on Supervision, with a minimum of three meetings held. A careful record should be kept, agreed between supervisor and student, of all such formal meetings, including dates, action agreed and deadlines set.

Delivery Method: The module is delivered primarily as an individual research project. The student is expected to liaise with the supervisor on a regular basis, with a minimum University requirement of three formal meetings for full-time students. In the case of part-time students it is recommended that a minimum of four meetings are held. Ideally, contact should be more regular, with at least one meeting a week to discuss the development and progress of the project. Depending on the project the student would be expected to carry out this research individually and to complete the necessary risk assessments and training required to work on an industrial site or within laboratory facilities of the University.

Module Aims: The module aims to develop fundamental research skills. It comprises the development of supervised research work leading to a dissertation in the field of the Master's degree programme. The specific research topic will be chosen by the student following consultation with academic staff.

Module Content: Study for the dissertation, which may be based on practical, industrial, or literature work, or any combination of these, is primarily carried out over a period of about 12 weeks, with the dissertation being submitted at the end of September. Preparatory work on the dissertation may take place during Part One of the programme but students will only be permitted to submit their dissertation following successful completion of Part One.

In conducting the research project and dissertation the student will be exposed to all aspects of modern information retrieval processes, the organisation and resourcing of research and the organising and presentation of experimental data. The student must make inferences on conclusions, based on the evidence provided and supported by the research work. Furthermore they must assess the significance of this work in relation to the field and make suggestions about how further work could improve or clarify the research problem. The results of the project will be disseminated in a substantial dissertation demonstrating the student's ability to research a subject in depth.

The student will meet regularly with the supervisor to ensure that the project is well developed and organised. Progress will be monitored.

Intended Learning Outcomes: On completion of this module, students should have the ability to:
• Investigate a research topic in detail;
• Formulate research aims;
• Devise and plan a research strategy to fulfil the aims;
• Carry out research work - undertake a literature search, a laboratory based or computer based investigation or a combination of these;
• Gather, organize and use evidence, data and information from a variety of primary and secondary sources;
• Critically analyse information;
• Make conclusions supported by the work and identify their relevance to the broader research area;
• Resolve or refine a research problem, with reasoned suggestions about how to improve future research efforts in the field; and
• Produce a report (dissertation), with the findings presented in a well organised and reasoned manner.

AHEP3 Learning Outcomes
SM1m A comprehensive understanding of the relevant scientific principles of the specialisation.
SM2m A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.
EA1m Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations
G1 Ability to apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
G3m Monitor and adjust a personal programme of work on an on-going basis

Assessment: Report (100%)

Assessment Description: The research project and dissertation forms Part Two of the Masters degree.

Students should refer to:
https://www.swansea.ac.uk/academic-services/academic-guide/postgraduate-taught-awards-regulations/standard-taught-masters/

In particular, section 14 will provide further Information about dissertation preparation and submission.

The word limit is 20,000. This is for the main text and does not include appendices (if any), essential footnotes, introductory parts and statements or the bibliography and index.

Each student is to submit an electronic copy of their dissertation through the Turnitin link on Canvas. The online system will automatically check the similarity of the report.

The dissertation must contain:

• A statement that it is being submitted in partial fulfilment of the requirements for the degree;
• A summary of the dissertation not exceeding 300 words in length;
• A statement, signed by you, showing to what extent the work submitted is the result of your own investigation.
• Acknowledgement of other sources shall be made by footnotes giving explicit references. A full bibliography should be appended to the work;
• A declaration, signed by you, to certify that the work has not already been accepted in substance for any degree, and is not being concurrently submitted in candidature for any degree; and
• A signed statement regarding availability of the thesis.

The dissertation is marked by the supervisor and another member of staff and sent to an External Examiner for moderation. An Internal Exam Board is then held to confirm the mark. Finally, all marks are ratified at the University Postgraduate Taught Examination Board.

Deadlines as follows:

MSc Civil, Structural and Computational Engineering (without resits) - September 30th

MSc Civil, Structural and Computational Engineering (with resits) - December 15th

Moderation approach to main assessment: Universal Double Blind Marking of the whole cohort

Assessment Feedback: Informal feedback will be given during regular meetings with supervisors. The supervisor will also provide an assessment of the project drafting skills during the planning of the dissertation. Work will be returned according to specified deadlines and accompanied by constructive comment.

A Feedback session will be given to any student who fails their dissertation and is permitted by the Award Board to resubmit their work.

Failure Redemption: Candidates who fail the dissertation are given an opportunity to resubmit the dissertation within 3 months of the result of the examination if a full-time student or 6 months for part-time students. Such students will be given one formal feedback session, including written feedback on the reasons for failure, immediately following confirmation of the result by the University Postgraduate Taught Examination Board. The opportunity to resubmit will only be offered to students who submit a dissertation and are awarded a fail. Those candidates who do not submit a dissertation will not be offered a resubmission opportunity.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment.
If an extension is deemed appropriate a Postgraduate Taught Masters 'Application for Extension to the Submission Deadline/ Period of Candidature' Form will need to be submitted as follows:
• 30th September – deadline for Part Two students (non-resit students)
• 15th December – deadline for Part Two Students (students who had resits)

EG-M07 Optimisation

Credits: 10 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof C Giannetti

Format: Timetabled lectures and example classes 30 hours;
Directed private study 70 hours
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Assessment:
Exam: Extended Coursework 80% (LO1, 2 & 3)
Continuous Assessment: 20% - Assignment 1 (LO1 & 2) and Assignment 2 (LO 2 & 3)

Module Aims: This module provides an introduction to some important techniques of optimisation that may be used across a broad range of engineering disciplines. The focus is on understanding the methods through hand calculation rather than the use of particular software packages. Numerical examples are employed to illustrate concepts and potential applications.

Module Content:
Indicative syllabus content:
1. Statement of optimisation and reliability problems.
2. Lagrange multipliers
3. One-Dimensional Minimisation Methods. Direct and indirect methods: unrestricted search; dichotomous search; golden section method; quadratic interpolation; Newton's procedures.
4. Extrema of functions of several variables.
5. Multidimensional Minimisation Problems - direct methods such as: Taxi-cab; conjugate search procedure
6. Multidimensional Minimisation Problems - indirect methods such as: Steepest descent method; Newton's method.
7. Linear Programming - the Simplex Method

Intended Learning Outcomes:
Technical Outcomes
Upon completion of the module the student should:
- Understand and be able to set up and carry out the necessary calculations for univariate unimodal optimisation problems LO1)
- Be able to use search techniques to determine the optima of unconstrained and constrained multivariable systems (LO2)
- Understand and be able to set up and carry out the necessary calculations for Linear Programming problems (LO3)

Accreditation Outcomes (AHEP)
- Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply a range of mathematical and statistical methods, tools and notations proficiently and critically in the analysis and solution of engineering problems (SM2m)
- A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations (SM5m)
- Understanding of concepts from a range of areas, including some outside engineering, and the ability to evaluate them critically and to apply them effectively in engineering projects (SM6m)
- Ability to collect and analyse research data and to use appropriate engineering analysis tools in tackling unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of engineering analytical methods (EA7M)
- Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D10M)

Assessment:	Examination 1 (80%) Coursework 1 (10%) Coursework 2 (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Exam - 80%
Coursework - 2 separate pieces which involve a selection of problems which utilise the optimisation methods taught. 20%

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback:
Examination - Standard Faculty of Science and Engineering exam feedback form.

Failure Redemption: A supplementary examination will form 100% of the module mark.

Reading List: Glyn James editor., Advanced modern engineering mathematics / Glyn James [and six others]., Harlow : Pearson Education Limited, 2011.ISBN: 9780273719236
Edgar, Thomas F., Himmelblau, David Mautner,, Lasdon, Leon S.,, Optimization of chemical processes / Thomas F. Edgar, David M. Himmelblau, Leon S. Lasdon., McGraw-Hill,, c2001..ISBN: 0071189777

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

This module assumes good mathematical skills and students will be expected to demonstrate a good understanding of partial differentiation, Taylor series expansion and matrices.

Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

Additional notes: Office hours, lecture notes and other teaching materials will be posted on Canvas.

EG-M126 Development of Virtual Reality Environments 1

Credits: 30 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Mr S Vowles, Mr EL Thomas

Format: 1x3 hour practical session per week.
1x3 hour seminar, brainstorming and student-support session.

Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

1x3 hour practical session per week.
1x3 hour seminar, brainstorming and student-support session.

Module Aims: Students will acquire the basic skills necessary to create their own 3D Virtual Reality environments utilising basic project and software management systems.

Module Content: Virtual Worlds (VW) are a key part of any Virtual Reality (VR) application. This section will cover memory palaces and how to design effectively for spatial memory retention. The Unity game engine will be introduced along with 3D modelling software (e.g. Gravity Sketch, Blender, Pro Builder) to create these Virtual Worlds. VR capabilities will be introduced with the VR frameworks (XR Interaction Toolkit, SteamVR, Oculus Integration) required to explore the worlds. The finished Virtual World is made into a simple VR application and then content ported to an online VR platform (e.g. Spatial).

Software Management
Any software project needs to consider Software Management so that the project reaches its goals. In this section, key skills and tools for the organisation and protection of the project will be introduced. Students will get taught how to critically think about VR applications via the Strength Weakness Opportunity Threats matrix (SWOT). Students will learn about various software project planning techniques (such as Waterfall, Prototyping, Minimum Viable Product, Spiral, Agile). Version control (Git, GitHub, Gitlab) and Planning tools (Planner, Trello, Kanban) and Team building tools (Teams, Slack, Discord) will be introduced to use alongside software management. The skills learnt in this section will be used for every other module going forward, in order utilise critical thinking, self-discipline, organisation skills and team building.

Programming
Computer programming, or coding, is a powerful skill for a VR developer to possess. Students will learn the basics of programming using C# in order to add custom functionality to their applications. This section will also teach students how to modify existing C# scripts and debug them to prevent issues from occurring. Eventually they will have the power to create editor scripts which can help automate their workflow and create their own digital tools. The VR areas of interaction will cover physics, sound, UX, databases and optimisation. The coding fundamentals will cover all the basics of such as methods, variables, loops, triggers, vectors etc.

Lighting and Sound
Lighting and sound are key parts of creating immersive virtual worlds. Students will learn how to use lightning to enhance the sense of presence and believability in virtual environments. Proper lighting cues help users perceive depth, scale, and spatial relationships accurately. Being able to light a scene well allows developers to direct the user's gaze to highlight important elements within the VR environment. Students will also learn how different setups can evoke specific moods and enhance the overall user experience. Sound is also very important and sometimes underrated factor which contributes to the overall experience of VR. Students will learn audio best practices, and how to develop a soundscape by using spatial sounds and ambisonic recordings. As well as lighting and sound, the overall art pipeline will be explored. 3D modelling tools (e.g. Blender, Gravity Sketch) apps can allow students to integrate their own assets into their worlds. Shaders and particle systems will also be covered teaching the possibility for complex VFX effects.

Artificial Intelligence (AI)
A fundamental part of VR is education of human interaction with applications, this is commonly done via Artificial Intelligences. This section will cover:
• Path-finding of Non-Playable Characters NPC.
• Create State machines for NPC’s to react to the players’ actions.
• Story branching will be taught to provide a programmable structure to the narrative choices.
• Utilise LLM AI models to increase NPC realism

We will also explore self-learning machines in the Unity environment, with both reinforced learning and unsupervised learning. In conjunction with AI, students will also learn the Mixed Reality (MR) workflow in order to bring AI driven characters into the real world.

Hackathon
Students will engage in teams on a short hackathon project where they will use their skills to create an app on a given theme.

Devices
Throughout the course students will learn how to use Head Mounted Displays (HMD) and Controller technology from a range of VR hardware companies including, Meta, HTC Vive, Pico, Varjo, Valve, etc. Augmented Reality (AR) through handheld devices (iPhone ARkit, Android ARcore, Vuforia) and Mixed

Reality (MR) (Quest Pro, HoloLens) through VR headsets will be used throughout the module. Additional technologies will also be covered such as eye tracking, additional trackers, light field displays, and scent modules will also be covered.

Intended Learning Outcomes: o Through the exploring of and exposure to various tools and assets, students will develop advanced VR skills enabling them to create working, organised and original applications.
o In solo VR development, students will exploit cross-disciplinary connections between theoretical and practical concepts.
o Students will be able to plan, present, evaluate and defend an original VR concept.
o Students will be able to appraise and value both solo and team based VR development approaches in order to best develop and design real VR applications.

Assessment:	Assignment 1 (10%) Assignment 2 (10%) Assignment 3 (20%) Assignment 4 (20%) Assignment 5 (10%) Group Work - Coursework (30%)
Resit Assessment:	Coursework reassessment instrument (100%)

Assessment Description: Assignment 1: (Virtual Worlds)
Weighting: 10%
By working on a basic problem the student will demonstrate in class their competency in a basic set of skills to include: Know the Project View Window, Manage Scene files, Navigate the Scene View Window, Reorganize the Unity interface, Understand Tags, Understand the Hierarchy Window, Understand the Inspector Window, Understand the Project View Window, Utilize the Inspector Window.

Assignment 2: (Software Management)
Weighting: 10%
By working on a basic problem the student will demonstrate in class the basic management tools of SWOT, the GIT repository and project planning.

Assignment 3: (Scripting)
Weighting: 20%
Evidence of working with and modifying existing C# codes and use of basic physics.

Assignment 4: (Advanced Lighting)
Weighting: 20%
A VR environment will be developed demonstrating elements of advanced lighting and 3D graphics and the ability to capture video footage from within the environment.

Assignment 5: (AI)
Weighting: 10%
A VR environment will be developed demonstrating different pathfinding methods, state machine and story branching.

Group Work - Coursework (Group Assignment)
Weighting: 30%
A small group exercise where teams will use the knowledge gained so far to pitch a potential VR project. This will include management tools and an informed and realistic project plan with timings based on experience to date.

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: All assessments will be 1-2-1 authentic, summative assessments by teaching staff according to openly available rubrics. Feedback therefore occurs during every assessment.

Failure Redemption: Students will be required to complete a 100% coursework resubmission.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

NA

EG-M190 Social, environmental and economic context of research

Credits: 10 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr SA Rolland, Prof JC Arnold

Format: 30 formal contact hours
10 x 1 hour lectures
10 x 2 hour interactive workshops

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Lecture and workshops

Module Aims: There is an increasing need for engineers to work towards complex, so called 'wicked problems', for example the secure supply of energy. This necessitates a holistic approach and involves making decisions based on a range of different factors, and consideration for economic, ethical, social, political and environmental, as well as technical limitations.

Obtaining and making sense of such information involves types of knowledge and the use of tools and techniques that have not always been traditionally used within engineering disciplines. For example, ethical issues concerning negative impacts on environment or society may raise questions of value, duty or morality and requires the application of moral reasoning rather than scientific reasoning.

During this module we will make use of a variety of engineering case studies which exemplify the need to consider non-technical aspects of engineering projects. We will use qualitative research approaches and ethical frameworks to help in our engineering decision making. We will also consider the role of the engineer in policy making.

Module Content: Different types of knowledge and research approaches used to obtain different types of knowledge and information
The use of moral reasoning and ethical frameworks
Policy process and the role of the engineer in informing policy

Intended Learning Outcomes: Technical Outcomes
By the end of this module students should be able to:
Knowledge of the stages of a research project and how to select appropriate research methods.

Accreditation Outcomes (AHEP)
Awareness of the need for a high level of professional and ethical conduct in engineering (EL8M / ET1fl)
Awareness that engineers need to take account of the commercial and social contexts in which they operate (EL9M/ ET2fl)
Awareness that engineering activities should promote sustainable development (EL11M / ET4fl)

Assessment: Coursework 1 (60%)
Coursework 2 (40%)
Participation Exercise (0%)

Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description: Assessment One: Selection of a contemporary engineering topic/project. Outline of the role of different types of knowledge and information needed to inform project. Ethical, economic, social and environmental evaluations of the engineering issues involved.
Assessment Two: A policy brief (choice of contemporary engineering topic)

PASS/FAIL COMPONENT Minimum attendance and contribution to workshop sessions
Note, that this module cannot be passed if this pass/fail element is not passed. If you do not meet the requirements of the Pass/Fail component, you will receive a QF outcome. This means that you will be required to repeat the failed component(s), even if your module mark is above 50%

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit
Assessment Feedback: Formative and peer feedback will be given in group/workshop sessions Feedback during Q&As in lecture and example classes. Lecturer available for ad-hoc feedback during office hours. Written feedback on all coursework submitted
Failure Redemption: Students will be provided with the opportunity to resubmit failed components. If engagement in group project activities is below required level, no supplementary will be possible and module will have to be resat in the following year.
Reading List: Singh, Pooja ; Singh, Lalit Kumar, Instrumentation and control systems design for nuclear power plant: An interview study with industry practitioners, Elsevier B.V, 2021-11.ISBN: 17385733 Szopiska-Mularz, Monika, Adaptive reuse of modern movement car parking structures for controlled environment agriculture: Results from an interview study for the innovative design process in cities, 2021.ISBN: 18779166 Zhu, Runhe ; Lucas, Gale M ; Becerik-Gerber, Burcin ; Southers, Erroll G, Building preparedness in response to active shooter incidents: Results of focus group interviews, Elsevier Ltd, 2020-09.ISBN: 22124209 Kim, Ji-Eun ; Kessler, Larry ; McCauley, Zach ; Niiyama, Itsumi ; Boyle, Linda Ng, Human factors considerations in designing a personalized mobile dialysis device: An interview study, Elsevier Ltd, 2020-05.ISBN: 00036870
Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus. .

EG-M192 Research Case Study

Credits: 10 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof Y Feng

Format: No formal lectures involved. Tutorials given by individual MSc research project supervisors (10h)
Directed private study (190h)
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

No formal lectures are involved. Student will meet their individual supervisors regularly (at least weekly) and will be guided the whole course of the module.

Module Aims: The aim of the module is to undertake an in-depth study into the use of research methods in engineering practice by carrying out a detailed literature survey and state of the art examination in a given topic of specialization.

Module Content:

• Literature review on chosen research topic.
• Familiarisation with chosen research topic.
• Planning of MSc thesis.

Intended Learning Outcomes: The student should be able to:

• Investigate a research topic;
• Identify the state-of-the-art and critically evaluate the main problems and necessary steps to move forward with their research topic;
• Formulate research aims;
• Sketch a research plan;
• Undertake a literature review;
• Gather, organize and use evidence, data and information from a variety of primary and secondary sources;
• Critically analyse information;
• Make conclusions supported by the work and identify their relevance to the research topic;
• Produce a report, with the findings presented in a well organised and reasoned manner.

AHEP3 Learning Outcomes
SM1m A comprehensive knowledge and understanding of the scientific principles and methodology necessary to underpin their education in their engineering discipline, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies
SM2m Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems
EA1m Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes
G1 Apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD

Assessment: Report (70%)
Oral Examination (30%)

Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description: Written report (70%)
Oral presentation (30%)

The report should be approximately 20-30 pages depending on the chosen MSc research topic, and the format and layout should follow the general guide provided by the module coordinator.

Page count is preferred to word count due to the nature of the content, i.e.figures, equations, etc.

The report will be electronically submitted to Canvas via Turnitin, and the online system will automatically perform similarity check.

Arranged by the supervisor, an oral examination will take place before 30th May. During the oral examination, the student is requested to give a PowerPoint presentation (no longer than 15 mins) to summarize his/her case study, followed by questions.

The written report (70%) and the oral presentation (30%) will be marked by the supervisor and another faculty member appointed by the supervisor. At the end of the oral examination, the examiners will provide technical feedback (not the final mark) on the case study.

Moderation approach to main assessment: Universal Non-Blind Double Marking of the whole cohort

Assessment Feedback: Student will be closely guided and supervised by his/her supervisor, through one-to-one tutorial meetings. In addition, technical feedback (not the final mark) will be provided to students during the oral exam.

Failure Redemption: Failure redemption is possible by the resubmission of the research case study.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Around 5,000 word report on the chosen MSc research topic.

Recommended Texts to be defined by supervisor according to the chosen research topic.

EG-M23 Finite Element Computational Analysis

Credits: 10 Session: 2023/24 September-January

Pre-requisite Modules: EG-323

Co-requisite Modules:

Lecturer(s): Prof R Sevilla

Format: Lectures 2h per week
Example Classes 1h per week
Directed private study 3h per week

Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

The module is delivered by lectures and example classes.

A comprehensive set of notes and a list of exercises will be are available for download via Canvas before the start of the course.

Communication and course announcements, including office hours details, will be made via Canvas.

Course materials, including the course notes and links to relevant webpages, will be available for download from Canvas.

Module Aims: This module introduces the fundamentals of the Finite Element Method to enable the student to use it in the solution of a range of problems of engineering interest. The classes of engineering problems covered in this module include elastic analysis of structures, heat conduction problems, seepage flow through soils and ideal fluid flow. In this context, MATLAB sample programs will be provided to illustrate the structure of a finite element software capable of solving these classes of problems.

Module Content:

- Review of the Finite Element Method for 1D elasticity and steady-state heat transfer
- Isoparametric finite elements
- High-order finite elements
- Numerical integration. Gaussian quadratures
- 2D heat transfer
- Seepage flow
- Irrotational flow.
- Quadrilateral elements
- 2D high-order finite elements
- Mesh generation
- Error measures
- 2D elasticity (plane stress, plane strain and axisymmetric problems)
- 3D elasticity
- Transient heat transfer
- Dynamics

Intended Learning Outcomes: Upon completion of this module students should be able to:
• Use the weighted residual method to solve an engineering problem governed by partial differential equations.
• Convert a realistic elasticity, heat conduction, seepage flow and ideal fluid flow engineering problems into finite element models.
• Solve elasticity, heat transfer, seepage flow and ideal fluid flow problems by hand using the finite element method.
• Use a software to set up and produce finite element solutions of engineering problems.
• Analyse/assess the output of finite element simulations.

Accreditation Outcomes (AHEP)

MEng
SM1 scientific principles and methodology necessary to underpin their education in their engineering discipline, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies
SM2m Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems
SM3m Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively
SM4m Awareness of developing technologies related to own specialisation
SM5m A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations
SM6m Understanding of concepts from a range of areas, including some outside engineering, and the ability to evaluate them critically and to apply them effectively in engineering projects
EA1m Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes
EA2i Ability to apply quantitative methods in order to understand the performance of systems and components
EA3m Ability to apply quantitative and computational methods, using alternative approaches and understanding their limitations, in order to solve engineering problems and implement appropriate action
EA4 Understanding of, and the ability to apply, an integrated or systems approach to solving engineering problems
EA6m Ability to extract and evaluate pertinent data and to apply engineering analysis techniques in the solution of unfamiliar problems
P1 Understanding of contexts in which engineering knowledge can be applied (for example operations and management, application and development of technology, etc.)
P3 Ability to apply relevant practical and laboratory skills
P4 Understanding of the use of technical literature and other information sources
P9m A thorough understanding of current practice and its limitations, and some appreciation of likely new developments
P11m Understanding of different roles within an engineering team and the ability to exercise initiative and personal responsibility, which may be as a team member or leader
G1 Apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
G3m Monitor and adjust a personal programme of work on an on-going basis
G4 Exercise initiative and personal responsibility, which may be as a team member or leader

MSc
SM1m A comprehensive understanding of the relevant scientific principles of the specialisation.
SM2m A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.
SM3m Understanding of concepts relevant to the discipline, some from outside engineering, and the ability to evaluate them critically and to apply them effectively, including in engineering projects.
EA1m Ability both to apply appropriate engineering analysis methods for solving complex problems in

engineering and to assess their limitations
EA3m Ability to collect and analyse research data and to use appropriate engineering analysis tools in tackling unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of engineering analytical methods.
D1m Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies
P2m A thorough understanding of current practice and its limitations, and some appreciation of likely new developments.
P4m Understanding of different roles within an engineering team and the ability to exercise initiative and personal responsibility, which may be as a team member or leader.
G1 Ability to apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD.
G3 Monitor and adjust a personal programme of work on an on-going basis.

Assessment:	Examination 1 (60%) Assignment 1 (40%)
Resit Assessment:	Examination (Resit instrument) (60%) Assignment 1 (40%)

Assessment Description: - Examination (60% of the module marks)
Standard university examination (open book).

- Assignment (40% of the module marks)
Group assignment where students are required to choose one of the following options:
1. Create a finite element model using commercial software to solve a realistic engineering problem in solid or fluid mechanics.
2. Modify an existing MATLAB program to solve an engineering problem using finite elements.

(*) Option 1 will require students to have access and to independently learn how to use the commercial software ANSYS.
To support this task, students will have access to
- online resources
- support from the Math and CAE Cafe offered by the College of Engineering.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback:
Examination - Standard university exam feedback form.

Assignment - Comments on submitted work will be sent to the groups.

Failure Redemption: Exam re-sits according to University regulations. A supplementary exam will form 60% of the module marks, with remaining 40% coming from the previously submitted coursework element.

Reading List: Fish, Jacob, author., Belytschko, Ted, 1943-2014, author., A first course in finite elements, John Wiley & Sons, 2007 - 2007.ISBN: 9780470510841
Chandrupatla, Tirupathi R.,, Belegundu, Ashok D.,, Introduction to finite elements in engineering / Tirupathi R. Chandrupatla, Ashok D. Belegundu., Pearson Education,, 2012.ISBN: 9780273763680
Rao, S. S., The finite element method in engineering, Elsevier/Butterworth Heinemann, 2011.ISBN: 9781856176613
Zienkiewicz, O. C., author., Taylor, Robert L. (Robert Leroy), 1934- author.; Zhu, J. Z., author., The finite element method : its basis and fundamentals, Butterworth-Heinemann, 2013.ISBN: 9781856176330
Zienkiewicz, O. C., author., Taylor, Robert L. (Robert Leroy), 1934- author.; Nithiarasu, Perumal, author., The finite element method for fluid dynamics, Butterworth-Heinemann, 2014.ISBN: 9781856176354

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Penalty for late submission of continual assessment assignment: No marks awarded for late submissions.

Available to visiting and exchange students.

This module requires a prior knowledge of:
1. Basic Finite Elements - more specifically, knowledge of the content of the module EG-323 is assumed.
2. Computer programming - more specifically, MATLAB programming language - at a fairly basic level.

EG-M325 Extended Research Case Study

Credits: 20 Session: 2023/24 September-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof R Sevilla, Refer To Dept

Format: Typically 1h weekly meeting with the supervisor.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

No formal lectures are involved. Student will meet their individual supervisors regularly (at least weekly) and will be guided the whole course of the module.

Module Aims: The aim of the module is to undertake an in-depth study into the use of research methods in computational mechanics.

A detailed literature survey and state of the art examination in a given topic of specialisation will be carried out. This might include revising or developing basic computational engineering codes in a given topic.

The topic of the case study will be in line with the research dissertation to be carried out in TB3.

Module Content: • Literature review on chosen research topic.
• Familiarisation with chosen research topic.
• Planning of MSc thesis.

Intended Learning Outcomes: On completion of this module, students should have the ability to:

• investigate a research topic in detail;
• formulate research aims;
• devise and plan a research strategy to fulfil the aims;
• carry out research work - undertake a literature search, a laboratory based or computer based investigation or a combination of these;
• gather, organize and use evidence, data and information from a variety of primary and secondary sources;
• produce a report, with the findings presented in a well organised and reasoned manner.

Accreditation Outcomes (AHEP)
SM1m A comprehensive understanding of the relevant scientific principles of the specialisation.
SM2m A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.
EA1m Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations
G1 Ability to apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD.

Assessment:	Report (70%) Oral Presentation (30%)
Resit Assessment:	Coursework reassessment instrument (100%)

Assessment Description: Written report (70%)
Oral presentation (30%)

The report should contain around 5,000 words depending on the chosen MSc research topic, and the format and layout should follow the general guide provided by the module coordinator. The report will be electronically submitted to Canvas via Turnitin, and the online system will automatically perform similarity check.

Arranged by the supervisor, an oral examination will be arranged by the supervisor. During the oral examination, the student is requested to give a PPT presentation (no longer than 15 mins) to summarize his/her case study, followed by questions.

The written report (70%) and the oral presentation (30%) will be marked by the supervisor and another faculty member appointed by the supervisor. At the end of the oral examination, the examiners will provide technical feedback (not the final mark) on the case study.

Moderation approach to main assessment: Universal Double Blind Marking of the whole cohort

Assessment Feedback: Informal feedback will be given during regular meetings with supervisors. The supervisor will also provide an assessment of the project drafting skills during the planning of the dissertation. Work will be returned according to specified deadlines and accompanied by constructive comment.

A Feedback session will be given to any student who fails their dissertation and is permitted by the Award Board to resubmit their work.

Failure Redemption: Failure redemption is possible by the resubmission of the research case study.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Around 5,000 word report on the chosen MSc research topic.

Recommended Texts to be defined by supervisor according to the chosen research topic.

EG-M83 Simulation Based Product Design

Credits: 10 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr AJ Williams, Dr B Morgan

Format: Lectures 6, Computer Lab 20, Reading/Private Study 20, Preparation for Assessment 54

Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Lectures and Computer Laboratory sessions will be delivered on campus.

Module Aims: This module provides an overview of the role that simulation can play in the design process of a product. A series of lectures introduce computational modelling and the computational tools and techniques employed in the design process. The application of simulation in the design of a number of industry based research projects is presented. Computer workshops lead students in using simulation tools and applying the tools in the optimisation of the design of a product.

Module Content:

• Introduction to computational modelling and the use of simulation in the design process: Examples, advantages, disadvantages.
• Information about commercial packages for each stage of the design process.
• Overview of steps involved in the modelling process; Identification of the physics involved, The effect of problem simplifications and assumptions on the solution, Determining an appropriate analysis type, The importance of validation.
• Introduction to steps involved in computational modelling, CAD and meshing: Examples of common problems associated with these stages of the design process and techniques to avoid them; importance of solution mesh independence, Solution procedures, simulation solver software, Post-processing, Interpretation of results, visualisation and optimisation,
• Introduction to software tools used in this module, CAD, meshing, analysis and visualisation packages.
• Analysis techniques: Overview of finite difference, finite volume and finite element methods, their advantages and disadvantages, and common applications for each method type.
• Case studies: application of the knowledge gained during the lectures to a) investigate the importance of solution mesh independence and b) optimise the design of a product using simulation.

Intended Learning Outcomes:
Technical Outcomes
On completion of this module the student will:
- Have the ability to apply computer-based models for solving problems in engineering and recognise the factors that influence model limitations. Assessed using Assignment 1 and 2.
- Demonstrate the ability to develop and apply a test strategy to produce an optimised design. Assessed using Assignment 2.
- Demonstrate an understanding of the modelling process and the role of simulation in design. Assessed using Assignment 2.

Accreditation Outcomes (AHEP):

MEng:
- Ability to apply quantitative and computational methods, using alternative approaches and understanding their limitations, in order to solve engineering problems and implement appropriate action (EA3m)
- A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations (SM5m)
- Work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies (D3m)
- Demonstrate wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D7m)
- Understand and evaluate business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics (D1)

MSc:
- Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations (EA6m)
- Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies (D9m)
- Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D10m)

Assessment:	Assignment 1 (20%)
	Assignment 2 (80%)
Resit Assessment:	Coursework reassessment instrument (100%)

Assessment Description:
• Assignment 1: Mesh Sensitivity Study.This is an individual piece of coursework.This coursework will involve the investigation of the influence of mesh dependence, convergence criteria and physical phenomena on a simulation solution. The results of the investigation will be presented in a written report (maximum of 15 pages).
• Assignment 2: Design Optimisation. This is an individual piece of coursework.This coursework will require the student to use simulation tools to optimise the design of a component subject to given criteria.The student will also be required to show their understanding of the role that simulation plays in the design process using examples presented within the module.This coursework will be presented in a written report (maximum of 20 pages).
• Supplementary Coursework.This is an individual piece of coursework. This coursework will require the student to use simulation tools to investigate and optimise the design of a given device. This coursework will be presented in a written report (maximum of 20 pages).

Moderation approach to main assessment: Universal Non-Blind Double Marking of the whole cohort

Assessment Feedback: Individual written feedback will be given using Canvas. An overall assessment of the cohort's performance for the coursework will also be published on Canvas.

Failure Redemption: A supplementary piece of coursework will be set which will form 100% of the mark. This assessment will cover the learning outcomes of both coursework 1 & 2.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available for visiting students. The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment.

EGIM02 Advanced Computational Methods for Engineers

Credits: 10 Session: 2023/24 September-January

Pre-requisite Modules: EG-228; EG-399

Co-requisite Modules:

Lecturer(s): Dr F Zhao

Format: Synchronous / Lectures 20h
Asynchronous & Directed Private Study 80h

Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Online based lectures and example classes, the course material will be available for download from Canvas.
Assessment: 30% continuous assessment assignments, 70% closed book examination.
Practical Work: Exercises/project will involve coding some of the methods presented in MATLAB.

Module Aims: Introduction to advanced computational (numerical) methods including ordinary and partial differential equations at masters level. The course provides an understanding of fundamental methods that form the basis of common solution techniques used in many simulators and commercial packages with wide application in science and engineering.

Module Content:

- Review of Basic Numerical Methods.
- Newton’s method
- Numerical Integration
- Discretization of Ordinary Differential Equations
- Discretization of Partial Differential Equations
- (All Types Elliptic, Hyperbolic and Parabolic)
- Finite difference and Finite volume methods
- Consistency, stability and convergence
- An Introduction to the Solution of Linear Systems
- Gaussian elimination
- Relaxation methods

Practical Work: Exercises/project will involve coding some of the methods presented in MATLAB
NOTE: Knowledge of some MATLAB or scientific programming is assumed.

Intended Learning Outcomes: Technical Outcomes
Demonstrate a knowledge and understanding of:
• The basic principles of: numerical integration, numerical solution of ordinary and partial differential equations. Truncation error and solution error. Consistency, stability and convergence. Direct and iterative solution of Linear systems of equations.
• Demonstrate the ability to (thinking skills): Understand and formulate basic numerical procedures and solve fundamental problems.
• Demonstrate the ability to (practical skills): Understand practical implications and behaviour of numerical methods and their solutions. Logically formulate numerical methods for solution by computer with MATLAB.
• Demonstrate the ability to (key skills): Study independently, use library resources. Effectively take notes and manage working time.

Accreditation Outcomes (AHEP)
- A comprehensive knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies (SM1m)
-Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply a range of mathematical and statistical methods, tools and notations proficiently and critically in the analysis and solution of engineering problems (SM2m)
- Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively (SM3m)
- A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations (SM5m)
- Understanding of concepts from a range of areas including some outside engineering, and the ability to evaluate them critically and to apply them effectively in engineering projects (SM6m)

Assessment:	Examination (70%) Assignment 1 (30%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Assessment is comprised of a closed book examination (70%) and 1 assignment (30%) involving analysis and computation.

Assignment. Questions on key components and concepts of the course material covered during the semester.

The examination and assessments tests knowledge and understanding of all the material presented.

Formative exercises are also set each week which also involve questions on key components and concepts of the course material to aid and reinforce learning and understanding.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Feedback on assessed work is given in example classes and via canvas.
Feedback on formative exercises is also given in example classes.
Specific issues and questions are answered throughout the module including example classes.
Feedback on formal examinations is given via a web feedback template.

Failure Redemption: The supplementary closed book exam paper is sat during the month of August following the first exam sat in January.
A supplementary examination will normally form 100% of the module mark and is capped at 50%.

Reading List: Gerald, Curtis F.,, Wheatley, Patrick O., Applied numerical analysis / Curtis F. Gerald, Patrick O. Wheatley., Addison-Wesley,, 2003.ISBN: 9780321133045
Johnson, Lee W., Riess, R. Dean, Numerical analysis / Lee W. Johnson, R. Dean Riess., Addison-Wesley Pub. Co.,, c1982..ISBN: 9780201103922
Smith, G. D., Numerical solution of partial differential equations : finite difference methods / G.D. Smith., Clarendon Press ;, c1985..ISBN: 0198596502
Paul. DuChateau, David W Zachmann; Paul DuChateau, Partial differential equations / Paul DuChateau, David W. Zachmann., McGraw Hill, 2011.ISBN: 9780071756181
DuChateau, Paul., Zachmann, David W., Schaum's outline of partial differential equations / by Paul Du Chateau and D.W. Zachmann., McGraw-Hill,, 1986.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Lecture notes provided.

Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.

Students must have completed Year 1 maths modules and EG-228 matlab or equivalent in order to take this module.

EGIM03 Solid Mechanics

Credits: 10 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof D Peric

Format: 2 Lectures and 1 Example Class per week. Directed private study 3h per week.

Delivery Method: Two lectures and one example class per week.
Assessment: 70% from end of teaching block 2 hour examination; 30% from 3 small assignments.

Module Aims: This module is concerned with the fundamentals of solid mechanics with particular attention given to elastic solids. Generic continuum mechanics concepts are introduced including basic geometric relations, balance principles and constitutive theory. This provides a basis for approximation methods and finite element method, in particular. Solution techniques of classical elasticity are employed in the solution of several engineering problems, including torsion of cylindrical bars and two-dimensional problems of elasticity.

Module Content: • Elements of Tensor Algebra: Points. Vectors. Tensors: Definitions and Notation. Spectral Theorem; Principal Invariants; Cayley-Hamilton Theorem. [3]
• Elements of Tensor Analysis: Differentiaton; Gradient. Divergence. Curl; Green's Formulae; Divergence Theorem. Stoke's Theorem. [3]
• Geometry and Kinematics of Bodies: Deformation of Bodies: Displacement. Green-Lagrange Strain Tensor; Infinitesimal Strain and Rotation. Properties of the Strain Tensor. Normal and Shear Strains. [3]
• Balance Principles: Linear and Angular Momentum Balance. The Stress Tensor. Local Equations of Equilibrium. Symmetry of the Stress Tensor; Properties of the Stress Tensor. Principal and Deviatoric Stresses; The Principle of Virtual Work. [3]
• Constitutive Theory: The Principle of Energy Balance - The First Law of Thermodynamics; Strain Energy Function;
Generalised Hooke's Law. The Elasticity Tensor; Isotropic Linear Elasticity: Constitutive Equations. Lame Coefficients. The Matrix Formulation. [3]
• The Boundary Value Problems of Linear Elasticity: Summary of Field Equations; Navier's Equations; Beltrami-Mitchells Compatibility Conditions; Formulation of the BVP; Uniqueness of Solution. [4]
• Solution of Selected Problems I: Torsion of a Cylindrical Bar. [5]
• Solution of Selected Problems II: The Plane Problem of Elasticity: Problem Description. State of Plane Strain. State of Plane Stress. Characterisation of the Stress Field. Airy's Solution. Formulation in Polar Coordinates. [6]

Intended Learning Outcomes: Students should be able to:
• Apply the fundamentals of solid mechanics to problems of elasticity.
• Formulate engineering problems in solid mechanics by considering geometry, equilibrium and constitutive theory.
• Use tensor calculus in the formulation and solution of solid mechanic problems.
• Perform analysis of torsion of arbitrary cross-section.
• Perform analysis of 2-D plane strain and plane stress engineering problems.
• Recognise situations in which closed form solutions are not feasible in solid mechanics, and approximation techniques are necessary.

Accreditation Learning Outcomes (AHEP)
SM1m A comprehensive understanding of the relevant scientific principles of the specialisation.
SM2m A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.
EA1m Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations
P1 Advanced level knowledge and understanding of a wide range of engineering materials and components.

Assessment:	Examination 1 (70%) Coursework 1 (10%) Coursework 2 (10%) Coursework 3 (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination 1 - Standard 2 hour university examination worth 70% of the final mark. Exam question related to the solution of a boundary value problem is a closed book question. For the remainder of the exam the use of lecture notes and worked exercises is permitted.
Coursework 1, 2 and 3 - Each students will need to complete three individual assignments that will require hand calculation. Each assignment will contribute 10% of the final mark, making assignments worth 30% of the final mark.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Examination 1 - Standard university exam feedback form.
Coursework 1, 2 and 3 - Marked assignments with comments will be provided to students for inspection.

Failure Redemption: Exam re-sits according to university regulations.
Normally, supplementary examination will form 100% of the module mark.

Reading List: Peric, D., Introduction to Solid Mechanics, Swansea University, lecture notes, 2009.
Timoshenko, Stephen P, Goodier, J. N., Theory of elasticity, by S.P. Timoshenko and J.N. Goodier., McGraw-Hill,, 1970.ISBN: 0070858055
Gurtin, Morton E., An introduction to continuum mechanics / Morton E. Gurtin., Academic Press,, 1981.ISBN: 9780123097507
Shames, Irving Herman,, Cozzarelli, Francis A.,, Elastic and inelastic stress analysis / Irving H. Shames and Francis A. Cozzarelli., Prentice Hall,, 1992.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Zero tolerance will apply for late submissions of the assignments.
Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.

EGIM06 Computational Fluid Dynamics

Credits: 10 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof P Nithiarasu

Format: Lectures and examples 30 hours.

Delivery Method: A total of 30 hours of lectures and examples. Two individual mini-projects on the implementation of computational fluid dynamics algorithms.
Assessment: Written closed-book examination (70%), projects (30%).
Penalty for late submission of continuous assessment assignment:
No marks awarded for late submissions.
Directed private study: 30 hours
Private laboratory work: 12 hours

Module Aims: This module provides a concise overview on the basic principles of computational fluid mechanics. The topics include finite difference and finite element methods, compressible and incompressible flows. Training will also be provided on the implementation of computational fluid dynamics algorithms.

Module Content: Introduction to CFD [1]
CFD model and applications [1]
Navier-Stokes equations [2]
Mathematical nature of equations [3]
Examples [2]
Spatial and temporal discretizations and examples [4]
Mini-project briefs [1]
Finite difference and finite volume schemes and examples [4]
Finite element schemes and examples [4]
Stabilized solution algorithms and examples [4]
Advanced topics [2]
Review and assessment [2]

Computer laboratory work: associated with mini-projects.
Project work: Mini-projects on computer implementation.

Intended Learning Outcomes: At the end of the module the student should be able to;
• Apply the knowledge of fluid dynamics equations, including initial and boundary condition, spatial and temporal discretizations and relevant mathematical aspects to the solution of practical fluid dynamic problems.
• To identify and evaluate the key issues relevant to discretization both in space and time.
• Create a computer code using any one programming language to solve fluid dynamic problems.
• Use computer codes to produce correct solutions.

Learning Outcomes (AHEP)
SM1m A comprehensive understanding of the relevant scientific principles of the specialisation.
SM2m A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.
SM3m Understanding of concepts relevant to the discipline, some from outside engineering, and the ability to evaluate them critically and to apply them effectively, including in engineering projects.
EA1m Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations
EA2m Ability to use fundamental knowledge to investigate new and emerging technologies.
EA3m Ability to collect and analyse research data and to use appropriate engineering analysis tools in tackling unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of engineering analytical methods.
D1m Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies
G1 Ability to apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD.
G3m Monitor and adjust a personal programme of work on an on-going basis.

Assessment:	Examination 1 (70%) Assignment 1 (15%) Assignment 2 (15%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: (i) Mini-project 1: Computer implementation of finite difference schemes (15%).
(ii) Mini-project 2: Computer implementation of a finite element scheme (15%).
(iii) Final examination: Closed book exam (70%).

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Feedback given on mini-projects 1 and 2. A overall feedback on the final examination will be posted online.

Failure Redemption: Resit may be allowed in exceptional circumstances - subject to university regulations. Assessment - 100% examination.

Reading List: Ch. Hirsch, Numerical computation of internal and external flows: fundamentals of computational fluid dynamics / Charles Hirsch., Elsevier/Butterworth-Heinemann, 2007.ISBN: 9780080550022
Hirsch, Charles., Numerical computation of internal and external flows. Volume 1, Fundamentals of numerical discretization / Charles Hirsch., John Wiley & sons,, 1988.ISBN: 9780471917625
Hirsch, Charles., Numerical computation of internal and external flows. Volume 2, Computational methods for inviscid and viscous flows ; Charles Hirsch., John Wiley & sons,, c1990..ISBN: 0471924520
O. C. Zienkiewicz author., Robert L Taylor (Robert Leroy), 1934- author.; Perumal Nithiarasu author., The finite element method for fluid dynamics / O. C. Zienkiewicz, R. L. Taylor, P. Nithiarasu., Oxford : Butterworth-Heinemann, 2014.ISBN: 9781856176354
R. W. Lewis (Roland Wynne), Perumal Nithiarasu; K. N Seetharamu, Fundamentals of the finite element method for heat and fluid flow / Roland W. Lewis, Perumal Nithiarasu, Kankanhalli N. Seetharamu., Wiley, 2004.ISBN: 9780470847893
1. P. Nithiarasu, R.W. Lewis and K.N. Seetharamu, Fundamentals of the finite element method for heat, mass and fluid flow.ISBN: 978-1-118-53543-1

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Penalty for late submission of continuous assessment assignment:
No marks awarded for late submission.

Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.

EGIM07 Dynamics and Earthquake Analysis of Structures

Credits: 10 Session: 2023/24 September-January

Pre-requisite Modules: EG-260

Co-requisite Modules:

Lecturer(s): Prof Y Feng

Format: Lectures & Example classes (30h); Directed private study (30h)

Delivery Method: Mixture of online lectures (live + recorded), face-to-face activities and unscheduled one-to-one (online) tutorials

Module Aims: This module aims to develop the understanding and skills necessary to analyse linear structures under general dynamic, including earthquake loading, and to understand the use of time stepping schemes for linear dynamic and transient problems.

Module Content:

• Introduction: Dynamic effects on structures, Engineering disasters, design issues. [1]

• Single Degree of Freedom Problems (SDOF): the SDOF spring-mass system, equivalent SDOF structures - energy method, analytical solution of SDOF problems, step by step solution methods, earthquake loading, response and design spectra, Eurocode- 8 elastic spectrum. [15]

• Multiple Degree of Freedom Problems: natural modes and frequencies of vibration, modal decomposition, reduction methods, earthquake loading, shear building model, design considerations. [9]

• Distributed Mass Systems: finite element discretisation and formulations. [4]

• Revision [1]

Intended Learning Outcomes: On the completion of the module, students are expected to be able to:

• Evaluate potential disastrous consequences of structural failures under dynamic loadings, such as strong wind, wave and particularly earthquakes.
• Apply the Rayleigh method to simplify a complex structure to a SDOF system; perform earthquake analysis of SDOF systems and apply knowledge of basic dynamic concepts of SDOF systems such as dynamic magnification, resonance and damping.
• Follow Eurocode-8 to conduct elastic earthquake analysis of a regular-shaped multi-story frame structure.
• Use a computer language to analyse the accuracy and stability of the Newmark integration method, and generate an earthquake spectra, based on which to conduct an earthquake analysis of a multi-story building.
• Determine Rayleigh vibration shape functions for simple structures.
• Distinguish between stiffness/mass/damping-dominated problems.
• Identify dynamic loading on bridges, footbridges, floors, etc. resulting from moving loads or rhythmic activities.

AHEP3 Learning Outcomes

MEng
EA1m Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes
EA2 Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques
EA4 Understanding of, and the ability to apply, an integrated or systems approach to solving complex engineering problems.
D6 Communicate their work to technical and non-technical audiences.
EL4 Understanding of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate.
P4 Understanding of the use of technical literature and other information sources.
P6 Understanding of appropriate codes of practice and industry standards.
G1 Ability to apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities.
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD.

MSc
SM1m A comprehensive knowledge and understanding of the scientific principles and methodology necessary to underpin their education in their engineering discipline, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies
SM2m Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems
SM3m Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively
EA1m Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes
EA2 Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques
P2m Knowledge of characteristics of particular equipment, processes or products, with extensive knowledge and understanding of a wide range of engineering materials and components
G1 Apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities
G2 Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
G3m Monitor and adjust a personal programme of work on an on-going basis

Assessment:	Examination 1 (40%) Project (60%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Exam - 40%

Project - 60%

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Offer one-to-one sessions to discuss the student's individual project; and use the College's standard module feedback procedure to provide the students with issues associated with the final examination.

Failure Redemption: 1. Students can redeem their failure by taking a supplement exam in August.
2. If students passed the exam component, but failed the individual project, the students have an option to redo the project without taking the supplementary exam.

Reading List: European Union, Eurocode-8 Part 1.
Chopra, Anil K., Dynamics of structures : theory and applications to earthquake engineering / Anil K. Chopra., Prentice Hall,, c2012..ISBN: 9780132858038
Anil K. Chopra author., Dynamics of structures : theory and applications to earthquake engineering / Anil K. Chopra., Harlow : Pearson Education, 2014.ISBN: 9780273774242
Clough, Ray W.,, Penzien, Joseph., Dynamics of structures / Ray W. Clough, Joseph Penzien., McGraw-Hill,, c1993..ISBN: 0071132414
Maguire, J. R., Wyatt, Tom,, Dynamics : an introduction for civil and structural engineers / J.R. Maguire and T.A. Wyatt., Thomas Telford,, 2002.ISBN: 9780727731388

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Assessment: Written, open book, examination (2 hrs) at the end of Semester 1 accounts for 60% of the marks, the remaining 40% are awarded to an individual project, for which students are expected to solve a dynamical problem using Excel/Matlab etc and write a technical report on their findings. Penalty for late submission of course work is zero mark in the course work.

The detail of the individual project will be provided at the beginning of the course.

EGIM08 Plasticity in Structural and Geotechnical Engineering

Credits: 10 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof D Peric

Format: Lectures (20h); Example classes and Laboratory work (10h). Directed private study 3h per week.

Delivery Method: Two lectures and one example or laboratory class per week.
Assessment: 50% from end of teaching block 2 hour examination; 50% from 2 projects.

Module Aims: This module is concerned with basic concepts and methods of computational plasticity. Essential steps required in numerical integration of elasto-plastic constitutive models are first discussed in a one-dimensional setting. Concepts of plasticity under multiaxial stress states are introduced and several yield criteria are described including von Mises, Tresca, Mohr-Coulomb and Drucker-Prager yield criteria. Details of numerical integration are provided for the von Mises yield criterion. Understanding of basic concepts and practical applications are strengthened through the programming exercises focusing on one-dimensional problems, and use of computational codes under multiaxial state of stress. Computer simulations of structural and geotechnical problems are performed, with the objective of understanding the concepts of engineering failure and limit state.

Module Content:

• Introduction: Historical Perspective. Physical Motivation. Rate Independent Plasticity. Rate Dependence. Creep. Rheological Models. [2]
• 1-D Mathematical Model: Yield Criterion. Flow Rule. Loading / Unloading Conditions. Isotropic and Kinematic Hardening Models. 1-D Elasto-Plastic Boundary Value Problem. [1]
• Computational Aspects of 1-D Elasto-Plasticity: Integration Algorithms for 1-D Elasto-Plasticity. Operator Split. Return Mapping. Incremental Elasto-Plastic BVP. Consistent Tangent Modulus. [5]
• Classical Model of Elasto-Plasticity: Physical Motivation. Classical Mathematical Model of Rate-Independent. Elasto- Plasticity: Yield Criterion. Flow Rule. Loading / Unloading Conditions. [6]
• Computational Aspects of Elasto-Plasticity: Integration Algorithms for Elasto-Plasticity. Operator Split. The Trial Elastic State. Return Mapping. Incremental Elasto-Plastic BVP. Consistent Tangent Modulus. [3]
• Plane Strain Von Mises Elasto-Plastic Model: Continuum. Integration Algorithm. Operator Split. The Trial Elastic State. Return Mapping; Incremental Elasto-Plastic BVP: Consistent Tangent Modulus. [4]
• Integration Algorithms for Generalised Elasto-Plasticity. [1]
• Generalisations and Applications of Plasticity: Plasticity in Engineering Practice: Geomechanics. Structural Mechanics. Impact Dynamics and Crashworthiness. [8]

Intended Learning Outcomes: Students should be able:
• Identify and select different constitutive models for describing material behaviour including von Mises, Tresca, Mohr-Coulomb and Drucker-Prager elasto-plastic models.
• Apply fundamentals of computational modelling of inelastic materials with emphasis on rate independent plasticity.
• Identify and apply different methodologies for discretisation of different time evolution problems, and rate-independent elasto-plasticity in particular.
• Formulate and implement a computational procedure for integration of rate-independent elasto-plasticity in 1-D.
• Perform analysis of engineering problems in elasto-plasticity by employing a commercial finite element package.
• Determine failure modes in engineering structures and geomechanics.

AHEP 3 Learning Outcomes

MEng
SM1m A comprehensive knowledge and understanding of the scientific principles and methodology necessary to underpin their education in their engineering discipline, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies
SM2m Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems
SM3m Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively
SM4m Awareness of developing technologies related to own specialisation
SM5m A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations.
EA1m Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes
EA2 Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques
EA3m Ability to apply quantitative and computational methods, using alternative approaches and understanding their limitations, in order to solve engineering problems and to implement appropriate action.
P2m Knowledge of characteristics of particular equipment, processes or products, with extensive knowledge and understanding of a wide range of engineering materials and components
P4 Understanding of the use of technical literature and other information sources
G1 Apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities

MSc
SM1m A comprehensive understanding of the relevant scientific principles of the specialisation.
Sm2m A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.
EA1m Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations.
P1m Advanced level knowledge and understanding of a wide range of engineering materials and components.
P2m A thorough understanding of current practice and its limitations, and some appreciation of likely new developments.
G1 Ability to apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities.

Assessment:	Examination 1 (50%) Assignment 1 (20%) Assignment 2 (30%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description:
Examination 1 - Standard 2 hour university examination worth 50% of the final mark. This is a closed book examination.
The coursework will consist of two individual projects that will require both hand calculation and computer simulations. Computer simulation will require certain amount of programming and use of the existing finite element software package Elfen. The project reports should consist of two parts: (i) a discussion related to general aspects of formulation and computational treatment of the problem under consideration, (ii) description of numerical solution of an individual problem.
Coursework 1 - Hand calculation and numerical solution in MATLAB will be used to obtain solution of simple 1-D elasto-plastic problem. Coursework 1 will contribute 20% of the final mark.
Coursework 2 - Short hand calculation and computer simulation in commercial code will be used to obtain solution of a 2-D engineering problem. Coursework 2 will contribute 30% of the final mark.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Examination 1 - Standard university exam feedback form.
Coursework 1 and 2 - Marked assignments with comments will be provided to students for inspection.

Failure Redemption: Exam re-sits according to university regulations.
Normally, a supplementary examination will form 100% of the module mark.

Reading List: Neto, Eduardo de Souza., Peric, Djordje, Owens, David,, Computational methods for plasticity : theory and applications / Eduardo de Souza Neto, Djordje Peric, David Owens., Wiley,, 2008.ISBN: 9780470694527
J. C. Simo (Juan C.), 1952-, Thomas J. R Hughes, Computational inelasticity / J.C. Simo, T.J.R. Hughes., Springer, 1998.ISBN: 9780387975207
Lubliner, Jacob., Plasticity theory / Jacob Lubliner., Dover Publications,, 2008.ISBN: 9780486462905
Owen, D. R. J., Hinton, E., Finite elements in plasticity : theory and practice / [by] D.R.J.Owen [and] E. Hinton., Pineridge Press,, 1980.
O. C. Zienkiewicz 1921-2009, R. L Taylor (Robert Leroy), 1934- author.; D. D Fox (David Dean), The finite element method for solid & structural mechanics / O.C. Zienkiewicz, R.L. Taylor, D.D. Fox., Amsterdam : Elsevier/Butterworth-Heinemann, 2014.ISBN: 0080951368
O. C. Zienkiewicz author., Robert L Taylor (Robert Leroy), 1934- author.; David Fox author., The finite element method for solid and structural mechanics / O.C. Zienkiewicz, R.L. Taylor and D.D. Fox., Oxford : Elsevier/Butterworth-Heinemann, 2014.ISBN: 9781856176347
Crisfield, M. A., Non-linear finite element analysis of solids and structures / M.A. Crisfield. Vol 1, Essentials., John Wiley,, 1991,.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Zero tolerance will apply for late submissions of the assignments.
Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.