MSc in Structural Integrity
Why study structural integrity at the National Structural Integrity Research Centre?

The National Structural Integrity Research Centre (NSIRC™) will be a state-of-the-art engineering facility for postgraduate training and industry led research. Established and managed by TWI, the Centre will work closely with lead academic partner Brunel University alongside the universities of Cambridge and Manchester to deliver highly qualified personnel and research to its key industrial partners.

This MSc in Structural Integrity is an industry-led degree offered by Brunel University, a recognised Centre of excellence in engineering and design which will combine academic excellence with the industrial experience of TWI across the varied disciplines that are essential to structural integrity.

Course aims
The course will focus on the knowledge and skills most relevant to a career in technical and engineering roles where understanding and achieving structural integrity is a key element.

It aims to produce engineers and technologists who can make a contribution to achieving and assuring structural integrity in industry through materials testing, structural analysis inspection, NDT techniques, and fitness-for-service assessment.

The key outputs are industry-ready, world-class engineers and technologists in structural integrity disciplines such as fail-safe design, corrosion control, structural health monitoring and ageing asset management.

Who is this programme designed for?
The programme is aimed at new graduates who wish to develop their careers in this direction, together with practising engineers who wish to gain a recognised postgraduate qualification in an important discipline.

Learning outcomes
The objective is to produce high quality engineers with an in-depth knowledge of the science and technology of structural integrity, materials degradation, ageing and inspection. The theory and principles of these disciplines will be covered in a set of eight taught modules. Application of theory will be consolidated during a research project. A graduate of this course will have integrated knowledge of materials performance, structural integrity and inspection engineering including:

- Understanding what structural integrity is and how it is achieved and demonstrated
- Awareness of the importance of good engineering
The MSc programme will combine academic excellence with the extensive up-to-date industrial experience of TWI’s experts across the many and varied disciplines that are essential to structural integrity.
specification and design
- Knowledge of how materials perform, age and degrade in different service environments
- Appreciation of the concept of a mitigation process and knowing how to manage integrity in-service
- Ability to apply advanced structural analysis techniques to determine stressors
- Knowledge of structural reliability analysis
- An understanding of structural condition monitoring
- Learning to develop appropriate risk based inspection, maintenance and service plans.
- Ability to choose between the capabilities and inherent limitations of different NDT techniques
- Ability to detect and quantify structural integrity issues by utilising appropriate NDT techniques
- Ability to make decisions when dealing with structures with flaws and other damage

The programme aims to equip students with an ability to oversee all aspects of structural integrity management and to use the necessary knowledge and skills to determine structural surveys and analyses and act on the results obtained. Topics covered will include numerical modelling, phased array ultrasonic inspection, fracture mechanics, risk based inspection, quality assurance, reliability engineering and risk management. While generic in character, the course will draw extensively from the solution of real problems from different industrial sectors.

Course Content
The course consists of 120 credits of compulsory and optional taught modules along with a 60 credit research project.

Part I
Compulsory modules:
Structural Integrity (15 credits)
This module is linked to CSWIP Plant Inspector Level 2 certification
Main topics and goals include:
- An introduction to structural integrity
  Examples of structures and components
- Modes of degradation and failures
- Appreciation of international codes and standards for construction
- Engineering design specification/evaluation
- Manufacturing and welding quality
- Tolerance of flaws in structures
- Run, repair replacement decision making process
- Practical case studies and application.

Metallurgy and Materials Degradation (15 credits)
Main topics include:
- Introduction to metallurgy and materials science
- Overview of materials classes commonly used in engineering applications, including:
  - Structural and low-alloy steels
  - Corrosion resistant alloys
  - Alloys for high temperature service
  - Light-weight structural materials
  - Polymers in engineering applications
- An overview of materials production routes, including
welding and joining processes

- Standard tests for the evaluation of materials properties, including:
  - Mechanical properties, hardness, corrosion, wear, microstructure, composition
  - Ageing degradation mechanisms in materials and the influence of joining - environmentally assisted cracking, fracture, fatigue, creep, high temperature oxidation, corrosion and wear.
- Materials selection for engineering applications
- Failure analysis and investigation
- Combating corrosion and wear by means of coatings or surface treatments
- Practical case studies and application.

NDT Inspection methodology (15 credits)
This module will:

- Enable students to identify the correct inspection methods to be applied for a specific task, ensuring they meet requirements and provide relevant input into an engineering assessment.
- Give students a knowledge of the principles of conventional (e.g., UT and ET) and advanced NDT methods and techniques (PAUT, thermography).
- Inform students how to plan an inspection strategy to meet specific requirements.

Plant, Process and Inspection (15 credits)
This module is linked to CSWIP® Plant Inspector Level 2 certification
Main topics and goals from this module include:

- Overview of the main processes within energy sectors including oil and gas and power generation.
- Operation of different types of major equipment within different assets.
- Impact of operation on structural integrity.
- Appreciation of inspection planning, complication with inspection, and mitigation through implementing an effective and optimised inspection regime.
- Introduction to risk based inspection and maintenance
- Understanding of cost benefit analysis.
- Practical case studies and application.

Condition Based Maintenance (CBM) (15 credits)
The objective of this module is to cover the key aspects of CBM via an introduction to vibration analysis and wave propagation based techniques such as acoustic emission and guided waves.
Main topics and goals from this module include:

- An understanding of the basics of time and frequency for vibration based methods of monitoring
- Data acquisition and normalisation.
- Practical measurement and analysis.
- Spectral analysis, dispersion, modal analysis and attenuation.
- Introduction to structural resonances and wave propagation.
- Analysis and fault finding.
- Recognition of poor data.
- Survey implementation using vibration based techniques of monitoring.
- Knowledge of basic reference standards.
- Statistical pattern recognition approach.
- Operational evaluation and correlation.
- Statistical model development.

Reliability Engineering and NDT Effectiveness (15 credits)

Topics covered are:
- Probability and component reliability theory
- Reliability block diagrams
- Hazard and operability (HAZOP) studies
- Failure modes and effects analysis (FMEA)
- Reliability centred maintenance
- Fault tree analysis
- Markov analysis
- Event tree analysis
- Monte Carlo simulation
- Approaches to inspection validation – standards and protocols
- Technical Justifications of NDT capability
- Theoretical modelling of NDT
- Analysis of data from experimental NDT trials – probability of detection, sizing errors, false calls.

Optional modules (choose 2):
Advanced Fracture Mechanics and Fatigue Analysis (15 credits)
The module covers:
- Brittle and ductile fracture, plastic collapse
- Linear elastic fracture mechanics (LEFM)
- Fracture toughness
- Fracture toughness testing
  - Two criteria approach
- Elastic-plastic analysis with J-integral
- Environmental-assisted cracking
- Cyclic stress and strain fatigue
- Effect of environment on fatigue
- Fatigue crack propagation
- Fatigue tests
- BS 7910 and other standards
- Case studies of engineering failures.

Advanced Radiography Testing (15 credits)
This module covers the theoretical background of digital radiography and computed tomography. Students will learn to:
- Explain current standards with reference to CR and CT systems
- Calibrate a CR system using a phantom
- Explain the image processing. Use software specific parameters to assess a digital image
- Recognise the constraints and capabilities of a CR and CT systems
- Modify the digital image to optimise defect detection.

Advanced Analysis in Structural Reliability Assessment (15 credits)
This module aims to equip students with the analytical tools to model uncertainty in engineering components and systems.
The module will cover:
- Basic variables and safety margin parameters.
- Distributions of load and resistance
- Concept of global and partial safety factors - Level I method
  - First and second order reliability methods (FORM and SORM) – Level II methods.
- Treatment of non-normal distributed variables in FORM.
- Treatment of correlated variables in FORM.
- Direct integration over the failure domain – Level III method.
- Directional simulation; importance sampling in simulation techniques. Reliability-based code calibrations.

Structural Health Monitoring (SHM) (15 credits)
This module will provide students with a thorough understanding of SHM implementation, systems, methodologies and tools. The subjects covered include:
An introduction to system identification methods used in SHM formulated within the framework of inverse problems.

Methodologies of identification in time and frequency domain, input/output or operational methods (output only), parametric and nonparametric.

Specific aspects associated with implementation of SHM.

Tools for uncertainty quantification as a frame for uncertainty and robustness assessment in complex applications.

Part II
Dissertation (60 credits)
Students will conduct research in the area of advanced NDT, structural life assessment, asset integrity management and reliability engineering. At the end of the research, students should produce a dissertation of not more than 30,000 words. It is anticipated that a large number of students will carry out their dissertation in industry.

Location
The course is based at Brunel University's School of Engineering and Design, situated at the Uxbridge campus. Some lab work may be conducted at TWI's premises in Great Abington, Cambridge.

Career development
The MSc in Structural Integrity provides the required advanced theoretical knowledge and essential practical skills for graduates to develop their career in the field of service and consultancy in oil and gas, power generation, petrochemical, nuclear and transport sectors. The NSIRC MSc course in Structural Integrity is accredited by The Welding Institute as further learning for registration as a Chartered Engineer.

Fees
£17,000 Home/EU/International Students.

Start date & duration
Start date: September/October 2013
1 year full time study

Scholarship funds provided by our industrial sponsors are available for exceptional applicants to the MSc Programme 2013 entry. The scholarship is open to both UK and international applicants.

For more information about applying for a scholarship, please email enquiries@nsirc.co.uk

Enquiries
For further information about this Structural Integrity MSc, please contact: enquiries@nsirc.co.uk

How to apply
Applications should be made through our website www.nsirc.co.uk

Entry requirements
Applicants must have:
- A UK first or second class Honours degree, or equivalent internationally recognised qualification, in a relevant branch of engineering or science; or
- Higher National Diploma, or equivalent, in a relevant branch of engineering or science with suitable post-HND work experience of typically three or more years or CSWIP/PCN/ASNT Level 3 qualification in any discipline will be considered. Two years’ work experience will be considered in exceptional circumstances.

Overseas applicants should have the minimum level of English language qualification:
IELTS: 6 (min.5.5 in all areas)
TOEFL paper test: 550 (TWE 4)
TOEFL Internet test: 79 (R18, L17, S20, W17)

* CSWIP
CSWIP is an internationally recognised competence assurance scheme accredited by UKAS in accordance with ISO/IEC 17024. CSWIP provides industry-led, role-specific compliance solutions for employers and specifiers engaged in manufacturing, construction, operation and maintenance of structures, plant and equipment.

This Structural Integrity MSc offers modules contributing towards CSWIP certification.

Disclaimer
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