Engineering Tripos Part IIB, 4D4: Construction Engineering, 2023-24

Module Leader

Dr B Sheil [1]

Lecturer

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Timing and Structure

Lent term - 14 lectures - Assessment: 100% coursework

Prerequisites

4D16 useful

Aims

The aims of the course are to:

- familiarise students with key design and construction aspects of those areas of construction engineering which are commonly encountered in many major civil engineering projects.

Objectives

As specific objectives, by the end of the course students should be able to:

- understand key issues in front-end planning and construction of major civil engineering infrastructure.
- understand the basics of construction site development, earth removing methods and earth excavation techniques.
- understand the basics for rock excavation and blasting.
- understand the practical considerations for loading and hauling operations including productivity estimation, fleet economics and equipment selection.
- understand the design, construction and operational aspects of compacting, finishing and paving operations for road infrastructure.
- analyse and evaluate the key principles and concepts of digital construction, including information modelling, monitoring,
- define the process of designing non-software specific modelling techniques in digital construction.
- apply critical thinking skills to assess the advantages and limitations of digital technologies in construction projects.
- evaluate and compare various digital tools and technologies used for project planning, design optimization, and data analysis.
- critically assess various types of sensors commonly used in construction as well as emerging trends and innovations in IoT and sensor technologies relevant to construction project monitoring.
- critically analyse a real-world case study involving the deployment of digital technology deployment in construction, to identify key challenges, innovative solutions, and lessons learned, and propose ways to adapt and apply these insights to address simi

Content

This module aims to familiarise students with key design and construction aspects of those areas of construction engineering which are commonly encountered in many major civil engineering projects. In Part 1, this will include earth moving and soil excavation techniques, rock excavation and blasting, road construction and equipment fleet economics. Earthworks are becoming increasingly important as massive rail and road projects are needed to cope with growing traffic. Rock excavation and blasting, as well as paving operations, provide particular challenges in many civil engineering projects. In Part 2, the students will start by gaining a firm grasp of digital modelling and its practical applications in construction projects. The module provides a deep dive into BIM as a popular exemplar of digital modelling. Students will explore the intricate processes involved in designing and executing BIM projects and learn how BIM extends into the fourth (scheduling) and fifth (cost) dimensions (4D/5D). The students will also gain an appreciation for the role of BIM in facility management (6D). Finally, the students will be provided with an overview of IoT and sensor technologies, discovering how these cutting-edge components can be integrated into construction processes for real-time data collection and analysis. A real-world case study will be used to highlight the transformative impact of these technologies in complex construction scenarios. Part 2 will end with an overview and run-through of the second coursework assignment.

Site development & earthmoving materials
Excavation techniques & earth moving methods
Loading and hauling
Road construction
Fleet economics
Introduction to digital construction and priority outcomes
An introduction to digital modelling
Designing and executing BIM projects
BIM for schedule (4D) and cost (5D) management
BIM for facility (6D) management
Construction monitoring: Internet of things (IoT) and sensor technologies
Case study: digital underground construction

8L, Dr Brian Sheil; 6L, Dr I. Brilakis

Coursework

Please refer to Form & conduct of the examinations [3].

This syllabus contributes to the following areas of the UK-SPEC [4] standard:

Toggle showing UK-SPEC areas [5].

Coursework	Format	Due date & marks
Coursework 1: Earthworks Construction earthwork and equipment: estimation of excavation soil volumes from drawings, earthwork production, blast design, logistics planning for transporting soils to/from project sites, paving and economics.	Individual Report anonymously marked	[30/60]
	Individual Report anonymously marked	[30/60]

Coursework	Format	Due date
Coursework 2: Digital Construction Development of a custom rule-based algorithm to automatically segment a specific element from a 3D point cloud (provided to the students) and recover key geometric features. Identification of the key steps involved in creating an IFC schema extension to accommodate custom objects and relationships, and the integration of such extensions into existing IFC-compliant software applications.		& marks

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [6].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [7] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

IA2

Demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

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