Knowledge Organiser

Level 3 - Unit 7 – Calculus to Solve Engineering Problems

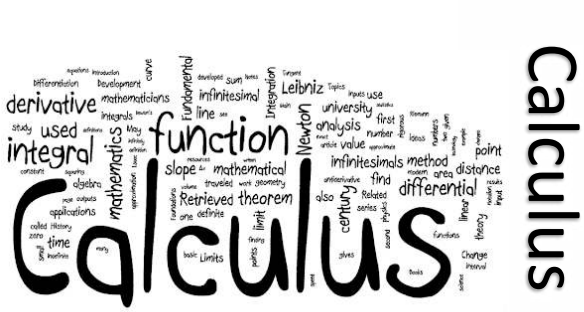
Learners use differential (rates of change) and integral (summing) calculus to solve engineering problems and develop a mathematical model of a local and relevant system

Unit Overview

Many of the products, components and systems that we use have been subject to a rigorous design process that will have involved the use of calculations including mathematical calculus. During the design stage, it is important to be able to predict how a product will perform in service, for example the handling characteristics of a car or the power output from an electrical power supply. Also, investing time and resources in setting up manufacturing machinery and supply chains is very expensive – working with formulae and numbers on paper or using a computer involves a lot less cost and allows engineers to determine optimal (or near-optimal) solutions.

In this unit, you will investigate how to apply differential and integral calculus methods to solve engineering problems. You will learn about the rules and procedures of calculus mathematics to obtain solutions to a variety of engineering problems. You will solve a complex problem from your specialist area of study and perhaps from a local organisation by breaking it down into a series of linked manageable steps. Each step will be solved using calculus methods learned through investigation and practice. These mathematical skills are transferable and will be used to support your study of other topics in the BTEC Nationals engineering programme, for example in mechanical principles and electrical systems.

As an engineer you need to understand and develop the skills required to solve problems using calculus and other mathematical procedures. This unit will prepare you well for progressing to higher education to study for an engineering degree or a Higher National Diploma (HND). It will also help prepare you for an apprenticeship or for employment in a range of engineering disciplines as a technician, and will help you work with professional engineers as part of a team working on cutting-edge products and systems



Learning Aim A

learners will demonstrate mastery in the application of differential calculus methods to the solution of given problems using mathematical functions. Learners will correctly and efficiently manipulate six routine and six non-routine functions. A reasoned and balanced evaluation (argument) will be presented when considering how variables can be optimised for at least two non-routine functions related to an engineering context, for example determining the dimensions of a container with a given volume so that its surface area is minimised, thereby minimising the material cost and environmental impact of the container.

Learning Aims:

A Examine how differential calculus can be used to solve engineering problems

B Examine how integral calculus can be used to solve engineering problems

C Investigate the application of calculus to solve a defined specialist engineering problem

Learning Aim B

learners will demonstrate mastery in the application of integral calculus methods to solve given problems using mathematical functions. Learners will correctly and efficiently manipulate eight routine and three non-routine functions.

Learners must present reasoned arguments when evaluating the use of analytical and numerical integration methods on at least two non-routine functions, for example finding work done by expressing parameters as a definite integral and then repeating the operation using Simpson's rule.

Learning Aim C

learners will demonstrate mastery in the application of calculus methods to solve a complex engineering problem. The identified problem must be sufficiently complex to allow learners to apply thinking methods, mathematical modelling and both differential and integral calculus methods to the solution of the problem. Learners must show that they are able to break a complex problem down into a series of manageable steps through the application of reductionism and logical thinking. Learners will produce a full specification for the problem, based on gathered and given information and use this to produce a proposal; there must be evidence that this has been done before they embark on the mathematical manipulations. Evidence for this could be supported by an assessor observation record.

Key Vocabulary

Near-optimal, differential,

Work Related Learning:

Gaining mathematics knowledge to assist in a manufacturing or Engineering career.

Numeracy links:

This unit is a maths and physics based units so covers a wide range on numeracy.

SMSC and British Values

Understanding the importance maths ad physics plays in solving serious world issues.