SCOTTISH QUALIFICATIONS AUTHORITY

Higher National Unit Specification

General information for centres

Unit title: Biomechanics

Unit code: DV3K 35

Unit purpose: The purpose of this Unit is to give candidates underpinning knowledge and practical skills in biomechanics and to apply the principles of biomechanics to human movement. This Unit will be relevant for candidates who are studying an HND in Applied Sciences, or candidates wishing to go on to study biomechanics at Diploma/degree level, or, specialists with an interest in biomechanics, eg physiotherapists and sports scientists.

On completion of the Unit the candidate should be able to:

1 Demonstrate knowledge and understanding related to biomechanics.
2 Collect, report and analyse information from experiments or simulations related to biomechanics.

Credit points and level: 1 HN Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Recommended prior knowledge and skills: Access to this Unit will be at the discretion of the centre, however, it is recommended that students have experience of studying mechanics and standard grade mathematics at credit level or the HN unit Mathematics for Science 1.

Core Skills: There are opportunities to develop the Core Skill(s) of Numeracy, Problem Solving and Communications at Higher in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Assessment: Candidates must meet the level of performance specified in the Evidence Requirements for both outcomes, to achieve the Unit. Outcome 1 will be assessed by a closed book assessment. Evidence for Outcome 2 should come from a practical activity or simulation on a relevant topic. Candidates should be assessed on both their practical activity and on the quality of their laboratory report.

Higher National Unit specification: statement of standards

Unit title: Biomechanics

Unit code: DV3K 35

The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Demonstrate knowledge and understanding related to biomechanics

Knowledge and/or skills

- Weight, mass, centre of mass, density
- Newton's laws of motion
- Free body diagrams
- Resolution of forces, vectors and scalars
- Resultant of orthogonal and non-orthogonal forces by numerical methods
- Moments involving rigid limbs
- Inertial Forces in moving limbs
- Circular motion — angular displacement, velocity and acceleration, moment of inertia, inertial torque and radius of gyration
- Body segment parameters — length, mass, centre of mass, radius of gyration
- Muscle groups involved in maintaining equilibrium
- Stages of gait cycle
- Force — time graphs in gait analysis

Evidence Requirements

Using a holistic assessment, a candidate's response can be judged to be satisfactory provided evidence is sufficient to meet the requirements for each item by showing the candidate is able to:

- calculate, when given horizontal and vertical motion information, ground reaction resultant forces acting on a foot correctly
- calculate the resultant of two orthogonal or non orthogonal forces using numerical methods correctly
- solve problems involving simple moments at joints on lower or upper limbs for orthogonal and non-orthogonal forces correctly
- draw free body diagrams, showing all forces acting on a limb, correctly
- solve problems involving inertial force correctly
- solve problems involving circular motion applied to a rotating limb correctly
- calculate a body segment parameter, from a given table with whole-body mass and height information correctly

- name the major muscle groups that are used to maintain equilibrium and state whether these are tending to flex, extend, abduct or adduct the limb correctly
- describe stages of normal gait:- heel strike, flat foot, mid stance, heel raise, toe off, mid swing and heel strike and the relative positions of ankle, knee and hip positions during each stage correctly
- interpret **a** graph of Vertical force (as a % of Body weight) against time in gait analysis correctly

Evidence should be gathered using a written/oral assessment under closed book conditions with a list of relevant relationships supplied as detailed in the guidance section. Evidence for outcome 1 can be demonstrated on a sample basis with 8 out of 12 knowledge and skills covered in each assessment occasion.

A sheet of relevant relationships, as indicated in the guidance notes, should be given to candidates.

Assessment guidelines

Outcome 1 could be assessed by a single, closed book, holistic assessment under supervised conditions. This assessment could take the form of a mixture of questions requiring a short descriptive answer, a response in the form of a numerical calculation, structured questions or a restricted response. An integrated approach is recommended for the assessment, which should be completed in approximately one hour. Should candidates fail to meet the pass criteria they should be offered a second attempt after sufficient remediation. Candidates will have to achieve a pass mark of 60% for this assessment although the minimum evidence for each knowledge and skill must be met.

Outcome 2

Collect, report and analyse information from experiments or simulations related to biomechanics

Knowledge and/or skills

- Setting up relevant equipment
- Safe methods of usage of equipment regarding Health and Safety Regulations
- Presentation of scientific information
- Recording of procedures, observations and measurements
- Experimental uncertainties — systematic and reading
- Evaluation

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- set up and perform the experiment/simulation from the instructions correctly
- describe the experimental procedures accurately, clearly and concisely
- record relevant measurements and observations in an appropriate format accurately
- analyse recorded information and present information in an appropriate format
- treat uncertainties appropriately
- draw valid conclusions

- evaluate the experimental procedures with supporting evidence

Evidence for this Outcome will be provided by the candidate performing one experimental assignment related to the theory in Outcome 1. Candidates should be assessed on their performance in carrying out the experiment, on their ability to record the observations and measurements correctly and on the analysis and conclusions provided. Candidates will need to successfully meet all the requirements for this outcome in order to pass the Unit.

Assessment guidelines

This Outcome will be assessed by a practical activity and all knowledge and skills must be assessed. Candidates should be assessed on both their practical activity by observation and on their ability to produce a satisfactory report. Evidence could be recorded in the form of a checklist.

It is recognised that centres will select experiments/simulations based on the equipment available to them however the experiment/simulation chosen must be relevant to biomechanics.

It is strongly encouraged that formative exercises are utilised to enable candidates to develop their skills in carrying out and reporting experimental work.

If the practical report fails to meet the required criteria, the report may be returned to the candidate and remediation offered. The report may be resubmitted once.

Administrative Information

Unit code: DV3K 35

Unit title: Biomechanics

Superclass category: PE

Date of publication: August 2005

Version: 01

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre for further details, telephone 0845 279 1000.

Higher National Unit specification: support notes

Unit title: Biomechanics

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This is likely to form part of a group award, designed to prepare candidates for employment in a science related post. This is a specialist unit that can be used as a stepping stone for candidates wishing to study biomechanics, bioengineering prosthetics and other related courses, at a higher level. It may also be of interest to candidates studying sports science.

Outcome 1 provides the underpinning knowledge of mechanics and applies it to the study of motion and forces acting on the human body.

The unit makes extensive use of:

- Force, weight, mass, density, centre of mass
- Distance, speed, displacement, velocity, acceleration
- Newton's laws of motion,
- Vectors including:- resultant forces (orthogonal and non-orthogonal forces), resolution into x and y components
- Inertial forces
- Simple moments
- Circular motion including: r, θ, ω,α, I, T

The Unit will look at the forces required by muscles to maintain equilibrium during various activities therefore the names of basic muscle groups should be studied for arms, legs, hips and the feet.

Candidates should be able to describe the effect of forces as "tending to"— flex, extend, abduct (move outwards), adduct (move inwards).

In reality, the body moves in three dimensions and control of limbs is by a complex interaction. of muscles, these muscles are attached to bones at varying angles. The net effect is studied by resolving moments in 3-D (x, y and z co-ordinate system). Three dimensional analysis is beyond the scope of this unit, but students could be made aware of the limitations of the 2-D approach.

Experimental methods and problems associated with collecting data such as body segment parameter data, position data and force data should be considered.

The style of gait including normal, stumble or pathological should be analysed. Graphs of vertical forces (as a % of body weight) are assessed. Graphs of horizontal forces on the foot are not to be assessed however they could be considered for completeness ie mediolateral (sideways forces that act as the guidance control) and anterior-posterior forces (from toe to heel).The effect of footwear on gait could be analysed.

Higher National Unit specification: support notes (cont)

Unit title: Biomechanics

Outcome 2 develops a wide range of skills associated with scientific enquiry and practical problem solving. Suggested practical activities could include:

- investigation of simple moments
- measurement of joint angles, using a goniometer, for a range of actions
- gait analysis using a force platform
- gait analysis using video recording equipment

The use of computers is a powerful aid to learning and experimenting. When interfaced to suitable sensors, the microcomputer can assist investigations where readings have to be taken very rapidly or over a period of time, or where several different variables have to be recorded simultaneously. Data obtained can be analysed and presented in graphical displays. Care should be taken, however, to ensure that candidates fully understand the presentation of such data when computer programmes are utilised.

Guidance on the delivery and assessment of this Unit

This Unit forms part of the Group Award, HND Applied Sciences which is primarily designed to provide candidates with knowledge and skills related to employment and/or further study in science. This unit should be delivered in a way that refers to applications to the occupational area of bioengineering. Instruments of assessment should be constructed with this in mind.

Assessment of Outcome 1 is by a supervised closed book assessment where candidates will be given a sheet of the relevant relationships (see below). The whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Where sampling takes place, a candidate's response in an assessment can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item specified in the Evidence Requirements. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Integration of the knowledge and skills in questions is recommended - for example:

- body segment parameters could be integrated in problems involving moments with rigid limbs, or circular motion, or inertial forces
- muscle groups could be added to the end of problems involving moments, inertial forces or circular motion

The practical or simulation work should relate to the theory being considered. It is advisable that several experimental activities are carried out during the delivery of the unit to enable skills to be developed and practise recording and reporting on experimental work can be gained.

Higher National Unit specification: support notes (cont)

Unit title: Biomechanics

Relationships required for Biomechanics

$F = ma$ $W = mg$ $\rho = m/V$

$$s = r\theta$$

$$v = \frac{s}{\Delta t} \quad ; \quad \omega = \frac{\theta}{t} \quad ; \quad v = r\omega$$

$$a = \frac{(v-u)}{t} \quad ; \quad \alpha = \frac{(\omega_2 - \omega_1)}{t} \quad ; \quad a = r\alpha$$

$I = md^2$ $I = Mk^2$ where M = total mass, k = radius of gyration

$IT = I\alpha = Mk^2\alpha$

Opportunities for developing Core Skills

Open learning

If this Unit is delivered by open learning methods, additional planning resources may be required for candidate support, assessment and quality assurance. A combination of new and traditional authentication tools may have to be devised for assessment and reassessment purposes

For further information and advice, please see *Assessment and Quality Assurance of Open and Distance Learning* (SQA February 2001 — publication code A1030).

Candidates with additional support needs

This Unit specification is intended to ensure that there are no artificial barriers to learning or assessment. The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Alternative Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs*, which is available on SQA's website: **www.sqa.org.uk**.

General information for candidates

Unit title: Biomechanics

This Unit introduces you to the basic concepts of biomechanics.

The human body is basically a machine. The way we move is controlled by the forces exerted by muscles. The muscles ensure that the body remains in equilibrium, and we move in a controlled way.

On completion of the Unit you will have underpinning knowledge of biomechanics, and will be able to describe styles of gait, and be able to apply the principles of biomechanics to analyse motion of the human body.

This Unit contains some analysis and the maths involved is of an Intermediate 2 level requiring simple trigonometry (sine, cosine and tangent), and algebra (ability to manipulate formulae).

The Unit will be assessed by an end of unit assessment and a practical assignment.

The written test will be supervised and you will be given a sheet containing the relevant relationships that you might use. The assessment will last approximately one hour and could take the form of a mixture of questions requiring a short descriptive answer, a response in the form of a numerical calculation, structured questions or a restricted response.

You will also perform and produce a report on an experiment or simulation.

If necessary, you may receive remediation and resit a different assessment and resubmit your laboratory report once.