[ESS32]

UNIVERSITY OF BOLTON

SCHOOL OF SPORT & BIOLOGICAL SCIENCES

BEng (Hons) BIOMEDICAL ENGINEERING

SEMESTER TWO EXAMINATION 2018/19

INTERMEDIATE BIOMECHANICS

MODULE NO: BME5004

Date: Tuesday 21st May 2019 **Time: 14:00 – 16:00**

INSTRUCTIONS TO CANDIDATES:

There are SIX questions on this paper, TWO questions in section A and FOUR questions in section B.

Section A: Answer ONE question

Section B: Answer TWO questions

Write your answers in the answer book provided NOT on the question paper. You must clearly label each answer with the corresponding section letter, question number and part letter.

Electronic calculators may be used provided that data and programme storage memory is cleared prior to the examination.

School of Engineering
Biomedical Engineering
Semester Two Examination 2018/19
Intermediate Biomechanics
Module No. BME5004

Section A: Experimental

Answer ONE question from this section.

1.

a) What is a piezoelectric force platform and how is it typically used in biomechanics?

(10 marks)

b) A young disabled athlete with bilateral amputation contacts you, enquiring as to the effect of two different types of running blade prostheses, on running technique and force production. How can the measure of Ground Reaction Force (GRF) using force platforms assist in scientific support? **Outline** an assessment session design for this group of athletes. In your design consider protocol and data analysis, including familiarisation and normalisation.

(30 marks)

c) It is possible to synchronise other biomechanics equipment to the force platform. What would this add to the assessment outlined above, in terms of additional biomechanical data, not otherwise available using the force platform only?

(10 Marks)

2.

a) **Outline** an experiment to conduct muscle imbalance assessment at the knee joints of a soccer player, 16 weeks post-ACL reconstruction, using the Isokinetic Dynamometer. **Provide details** of experimental design including familiarisation and speed selection.

(30 Marks)

b) With reference to literature, **discuss** the reliability and validity of isokinetic strength assessment using a dynamometer in the context of soccer.

(20 Marks)

END OF SECTION A

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<u>Section B:</u> Theoretical

Answer <u>TWO</u> questions from this section.

3.

a) Calculate the **linear tangential velocity** of a cricket ball, at the instance of release during a fast bowl. The ball in the hand has an angular velocity of 32.1 rad • s^{-1} and bowlers arm (radius of rotation) is 1.2 m in length.

(3 marks)

b) During the next over, the original bowler (in question 3a) is replaced with a reserve bowler, who has an arm length of 1.09m, but rotates his arm at a higher angular velocity of 36.9 rad • s^{-1}.
Calculate the **linear tangential velocity** of the new bowler.

What is the **% change** in point of release velocity between the two bowlers and **explain** why this difference exists?

(7 marks)

c) Calculate the **linear tangential velocity**, **tangential acceleration** & **radial acceleration** for the distal end of a robotic surgical arm, when it is rotating with a constant angular velocity of 3.14 rad • s^{-1}, for a time of 0.76 s. The length of the arm from its' centre of rotation is 2.34 m.

(15 Marks)

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4.

a) Using the Parallel Axis Theorem calculate the **moment of inertia** of the left leg about the hip axis of a sprinter's leg below (see figure 1).

(15 Marks)

Sprinter's mass = 82 kg

Segmental mass ratios:

Thigh = 0.103 (10.3%)
Shank/Calf = 0.043 (4.3%)
Foot = 0.015 (1.5%)

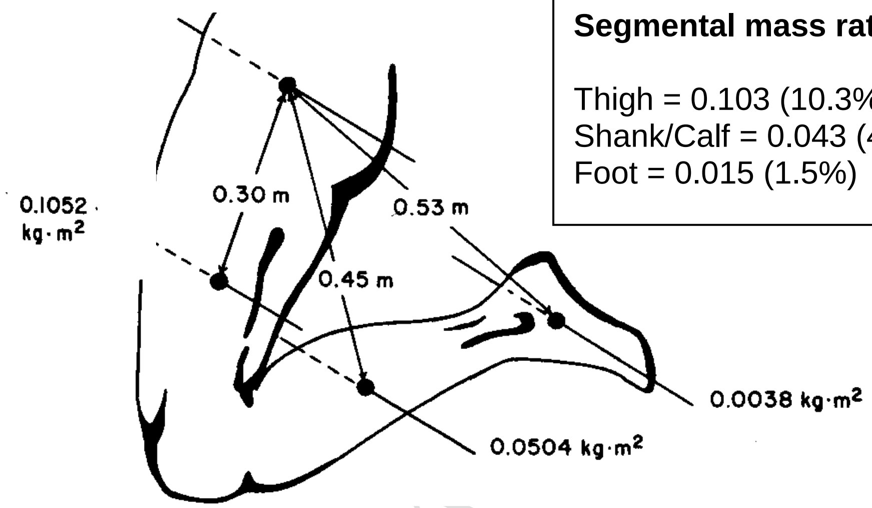

Figure 1. Sprinter's leg in recovery swing phase, position 1.

b) Calculate the **moment of inertia** for the same sprinter who is now able to recover this leg with an increase in knee flexion (see figure 2).

(10 Marks)

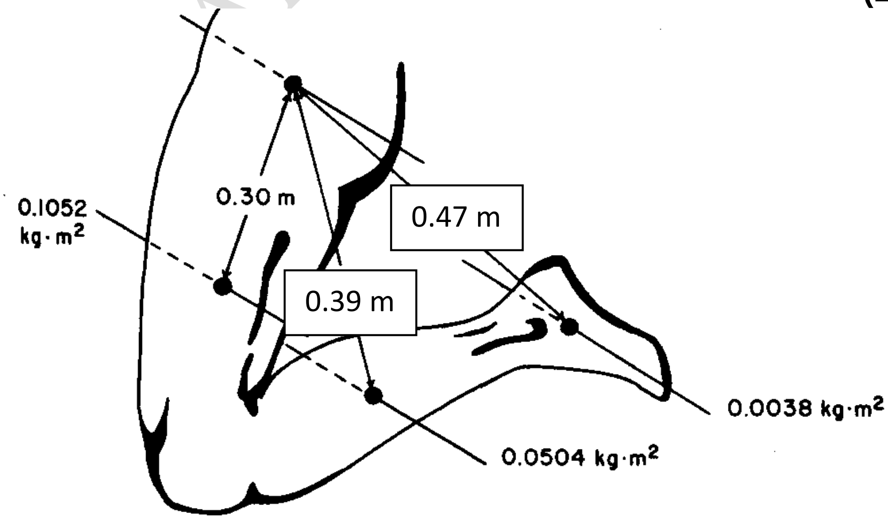

Figure 2. Sprinter's leg in recovery swing phase, position 2.

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5.

a) A long jump athlete (mass = 67.8 kg) has a horizontal velocity of 7.8 m·s^{-1} and a vertical velocity of -3.4 m·s^{-1} (i.e., downwards) immediately before take-off, as her foot hits the floor.
During the take-off phase she generates 1213.14 N·s of vertical impulse and -56.7 N·s of horizontal impulse (i.e. braking impulse).

What is the vertical, horizontal and resultant velocity of the long jumper at take-off and what is the take-off angle of the jumper?

(15 Marks)

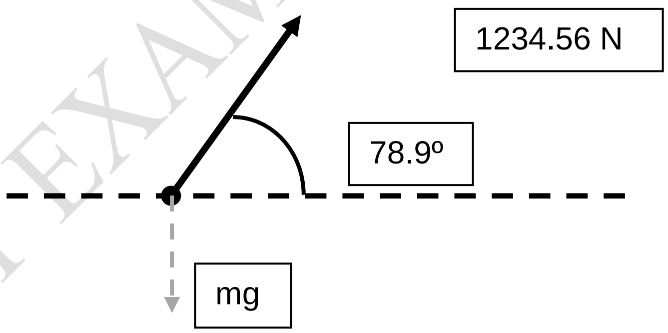
b) In training, a fellow high jumper (mass = 78.9 kg) generates 567.8 N·s of net vertical impulse just before take-off. What is their take-off velocity and jump height for this performance?

After some plyometrics training, 12 weeks later, the athlete performs the same jump test and achieves a net impulse of 678.9 N·s. What was their gain in jump height in absolute terms and as a % increase?

(10 Marks)

6.

a) Calculate the resultant acceleration during stair ascent, for a person of 56.78 kg mass who is applying a thrust of 1234.56 N at 78.9 º to the horizontal.



(15 Marks)

b) If the person applies 1500 N, at 55° to the horizontal, on the next step, what is the difference, presented as a percentage (%), in acceleration?

(10 marks)

END OF QUESTIONS

Formulae
$v_t = \omega r$
$a_t = \alpha r$
$a_r = v_t^2/r$
$\alpha = \boldsymbol{\Delta\omega / \Delta t_1}$
$I_{(hip)} = I_{cg} + md^2$
$F \times t = (m_2 - v_2) - (m_1 - v_1)$
$u^2 = v^2 + 2as$
$\sin\theta = Opp/Hyp$
$\cos\theta = Adj/Hyp$
$\tan\theta = Opp/Adj$
$Opp^2 + Adj^2 = Hyp^2$