UNIVERSITY OF GHANA
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FIRST SEMESTER EXAMINATIONS: 2013/ 2014

LEVEL 300: BACHELOR OF SCIENCE IN ENGINEERING

BMEN 307: BIOMECHANICS (3 CREDITS)   **DURATION: 2.5 HOURS**

SECTION A (15 POINTS)

Provide short answers for the questions below in the answer booklet provided. (1 POINT EACH)

1. Which plane divides the body into upper and lower parts..
2. The bone that has a relatively high porosity is called...
3. Cortical bone is strongest in resisting which type of stress...
4. Bone growth in the longitudinal direction is due to which cellular element............................
5. What happens to bones in the absence of gravitational force ....
6. Where is the series elastic component of a muscle found?...
7. A contraction in which there is no change in length is ....
8. The behavioural property of muscle tissue is defined as "the ability to respond to a stimulus". This is referred to as.....................
9. Which part of the body will you find fibro cartilage?..
10. The resistance arm will always be longer than the force arm in what class lever.......................
11. Third class lever systems favour what mechanical advantage...
12. Closed packed position of a joint will enable..
13. Where are the golgi tendon organ located?...
14. What connective tissue attaches muscle to bone...
15. What connective tissue attaches bone to bone...

SECTION B: ANSWER ALL QUESTIONS (86 POINTS)

1.

a. Draw and explain the length – tension curve of a muscle and make sure to include the passive and active components of the muscle.   (8 POINTS)

b. Briefly describe the structure responsible for the active and passive components represent in the human muscle   (4 POINTS)

c. Sketch and explain the force – velocity curve of the muscle.   (6 POINTS)

d. Briefly describe **three (3)** factors that affect force production in the muscle   (6 POINTS)

e. A unipennate muscle produces $60\ N/cm^2$ of force, where the area in question is the physiological cross sectional area. The total physiological cross sectional area of the muscle is $15cm^2$ and the angle of pennation is $15°$. How much tension is produced in the muscle tendon that runs longitudinally (i.e. at $15°$ to the fibres in this case)   (4 POINTS)

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f. List (do not discuss) 6 factors that affect force generating capacity of a muscle. (3 POINTS)

2. At the rehabilitation clinic, Effie is asked to put her knee in the position as shown in the diagram below. The weight of the body is 100 kilograms, the weight of the leg is 11% of the total weight of the body, M is the force due to the muscles on the lower leg.

Additional information given: distance from reaction force to point of muscle insertion (OA) is 12 cm; distance from reaction force to point of weight of the leg (OB) is 22 cm; distance from reaction force to the foot (OC) is 50 cm, $\theta = 15°$ and $\beta = 45°$.
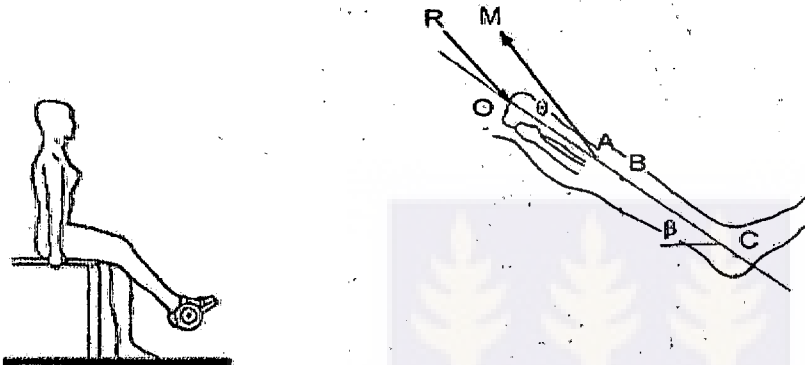

Figure 1: Effie at the rehabilition clinic

a. Draw a free body diagram of the knee joint (3 POINTS)
b. Calculate both vertical & horizontal distances of OA, OB, and OC (6 POINTS)
c. Calculate R: that is the reaction force on the leg from the knee (R_x & R_y) (6 POINTS)
d. Calculate the muscle force M that attaches to the leg (5 POINTS)
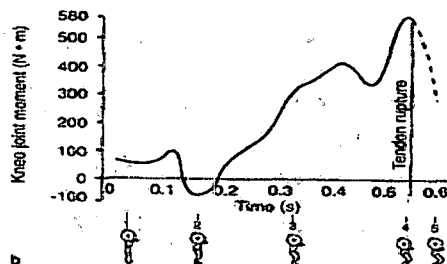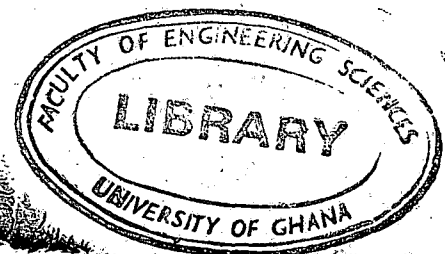

Figure 2: An Olympic weight lifter

EXAMINER: S. Tetteh

9. John exercises his left shoulder rotators at the University of Ghana gym.

   a. Draw a free body diagram of this system.   **(3 POINTS)**

   b. Calculate the forces and the moments exerted on his shoulder **(7 POINTS)**

$F=200$ N
$a=25$ cm
$b=30$ cm

EXAMINER: Sophia Tetteh