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MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

I SEM M.Tech (BME) DEGREE END SEMESTER EXAMINATIONS NOVEMBER 2019 SUBJECT: BIOMECHANICS & BIODYNAMICS (BME 5152) (REVISED CREDIT SYSTEM)

Saturday, 23rd, November 2019, 2 to 5 pm

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to Candidates:

1. Answer all questions.

- 2. Draw labeled diagram wherever necessary.
- 1A. How do clinical biomechanists analyze motion in order to improve human movement? 04
- 1B. Justify with reasons to explain how cortical bones exhibit strong anisotropic 03 characteristics.
- 1C. Consider performing CRAC method on hamstrings muscle. Write the complete 03 procedure to explain how the method can be effectively performed.
- 2A. A basketball player is trying to dunk the ball and leaves the ground with a vertical 05 velocity of 3.5 m/s.
 - (a) What is the player's vertical acceleration immediately after takeoff?
 - (b) What is the peak height the player's center of gravity will attain if it started at 1.2 m?
 - (c) How much time elapses before the player will reach his peak height?
- 2B. A 0.15 kg baseball strikes the catcher's glove with a horizontal velocity of 40 m/s. The 05 displacement of the baseball due to the deformation of the catcher's glove and the movement of the catcher's hand is 8 cm in a horizontal direction from the instant it first makes contact with the glove until it stops.
 - (a) How much kinetic energy does the baseball possess just before it strikes the glove?
 - (b) How much work does the catcher do on the baseball during the catch?
 - (c) What is the average impact force exerted by the glove on the baseball?
 - (d) Is the work done positive or negative?

- 3A. Explain in detail about the stride parameters and their relationship which are commonly 04 used to analyze the linear kinematics of walking and running.
- 3B. With an appropriate example, explain why kinetic energy of a system needs to be 03 considered as the ability to perform work in order to change the momentum of the system.
- 3C. Differentiate the kinds of muscle actions that occur during the angular work performed 03 by the muscles while lifting and lowering a barbell.
- 4A. An athlete is doing a knee extension exercise using a 100 N dumbbell strapped to her 05 ankle at 40 cm from her knee joint. She holds her leg so that the horizontal distance from her knee joint to the dumbbell is 30 cm.
 - (a) For this position, what torque is created by the dumbbell about the axis through her knee joint.
 - (b) If the moment arm of the knee extensor muscles is 4 cm about the knee joint axis, what amount of force must these muscles produce to hold the leg in the position described? Ignore the weight of the leg.
- 4B. Use the 'Inverse Dynamics Approach' to calculate the torque and joint reaction forces 05 at hip. The thigh segment's mass, angular acceleration and moment of inertia are 4.8 kg, -3rad/s² and 1 kg.m² respectively. The linear accelerations (horizontal and vertical) of the segment acting at the center of mass of the segment are 2 m/s² and 4 m/s² respectively. The torque, horizontal JRF and vertical JRF at the knee joint are -10 Nm, 20 N and 50 N respectively. The horizontal distances from the com to hip joint and from knee joint to com are 0.2 m and 0.25 m respectively. The vertical distances from the com to hip joint and from knee joint to com are 0.1 m and 0.15 m respectively.
- 5A. Illustrate to show how a javelin can be projected in an effective way so that it completes 04 its trajectory before landing. Also, show what might cause the stalling of a javelin.
- 5B. Demonstrate with pictorial representation to explain the ability of the human body to 06 float.