Reg. No.



MANIPAL INSTITUTE OF TECHNOLOGY

1st SEMESTER M.Tech. (BME) DEGREE END SEM EXAMINATIONS NOVEMBER 2017 SUBJECT: BIOMECHANICS & BIODYNAMICS (BME 5104) (REVISED CREDIT SYSTEM) Thursday, 23rd November 2017: 9 AM to 12 NOON

TIME: 3 HOURS

MAX. MARKS: 100

Instructions to Candidates:

1. Answer all the questions.

2. Draw labeled diagram wherever necessary.

1. (a) (i) Differentiate quantitative biomechanical analysis from the qualitative 02+06 biomechanical analysis of human movement.

(ii) Provide a list of movements that occur at the joints of the upper and lower extremities, along with their description, in the case of Sprinting.

- (b) What are the biomechanical principles of human movement that play an important role in increasing the speed of objects that are projected in the air, and also in decreasing from high speed?
- (c) (i) A ball is kicked to a horizontal distance of 45.8 m. If it reaches a maximum height 02+04 of 24.2 m with a flight time of 4.4 seconds, was the ball kicked at a projection angle less than, greater than or equal to 45°? Justify your answer based on the appropriate calculations.

(ii) Illustrate the sub-phases of the support-phase during a human gait cycle.

(a) (i) The biceps-muscle exerts a pulling force of 800 N on the radius-bone of the forearm. The force acts at an angle of 30° to the radius-bone in the anterior and superior direction. How large is the component of this force that pulls the radius-bone toward the elbow joint, and how large is the component of this force that pulls perpendicular to the radius bone?

(ii) What is the percentage of the resting length of the skeletal muscle at which maximum muscle-tension is developed? Explain the contribution of the components of the musculotendinous unit responsible for the generation of total tension in the muscle.

- (i) Explain the procedure followed to stretch the gastrocnemius muscle using the **(b)** 04 + 02"Proprioceptive Neuromuscular Facilitation" stretching routine. (ii) Describe as to how the muscle spindles and the golgi tendon organs may enhance or detract from the effectiveness of a stretching exercise.
- What are the disadvantages of multi-joint muscles? 06 (c)
- 3. (i) The biceps brachii muscle, attached to the radius bone at a distance of 2.5 cm from (a) 02 + 06the elbow joint, produces a muscle tension of 250 N perpendicular to the bone. The triceps brachii muscle, attached to the radius bone at a distance of 3 cm away from the elbow joint, exerts 200 N of muscle tension perpendicular to the bone. Calculate the net torque at the elbow joint. Will there be flexion, extension or no movement at the joint?

(ii) Provide an example pertaining to the human body to represent each class of lever.

- Explain the pattern of the vertical ground reaction force generated during the support **(b)** 06 phase of the gait cycle while running.
- Considering the value of the Young's modulus for long bone to be 30,000, what strain (c) 06 energy is required to deform the bone to a strain of 0.1%? How much strain energy is stored in the bone if it is exposed to a stress of 30 MPa?
- 4. (i) A boxer punches a heavy bag. The time of impact of the glove with the bag is 0.1 02 + 06(a) seconds. The mass of the glove and his hand is 3 kg. The velocity of the punch just before the impact is 25 m/s. What is the average impact-force exerted on the glove?

(ii) Provide two examples pertaining to human movement to explain how the moment of inertia is reduced to increase the angular acceleration.

(b) (i) What is 'wave drag force'? How can the 'wave drag force' be reduced while 03+03 swimming?

(ii) Draw a graph to represent the various forms of energy generated during the various phases of the gait cycle.

- (c) Explain the factors that determine the stability of a human body. 06
- 5. (i) The weight of the arm is 33 N. The moment-arm for the total arm segment is 30 cm 04 + 04(a) from the shoulder joint, and the moment arm for the deltoid muscle is 3cm from the shoulder joint. How much of force must be produced by the deltoid muscle to maintain the arm in the horizontal position (90° from the anatomical position) in the lateral direction? Calculate the joint reaction force, and draw the free body diagram.

(ii) Provide an example to explain how terminal velocity is reached in sport-activities.

- How is 'magnus force' generated in the case of a ball undergoing right-spin? Draw the **(b)** 06 trajectory and explain in detail.
- Explain in detail, 'paddling' and 'sculling' movements. (c)

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