Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL A Constituent Institution of Manibal University

I SEMESTER M.Tech. (BME) DEGREE END SEM EXAMINATIONS NOV/DEC 2016 SUBJECT: BIOMECHANICS & BIO-DYNAMICS (BME 5104) (REVISED CREDIT SYSTEM)

Thursday, 1st December 2016, 9 am to 12 noon

TIME: 3 HOURS

MAX. MARKS: 100

6

2+ 6

Instructions to Candidates:

- 1. Answer all FIVE full questions.
- 2. Draw labeled diagram wherever necessary.
- 1. (a) Explain the principles of force-motion, force-time and range of motion as applied to 7 human movement.
 - (b) Define the movements of all body segments that move away from midline of the body in the lateral direction.
 - (c) (i) A punter kicks the football, which leaves the punter's foot with a vertical velocity of 20 3+5 m/s and a horizontal velocity of 15 m/s. For how long is the ball in the air? Consider the effect of air resistance and assume that the height of release and landing are same.

(ii) Draw the mathematical model for sprint race velocity curve and explain it.

- 2. (a) Make a comparison of various types of muscle tension.
 - (b) A weightlifter has mistakenly placed a 20 kg plate on one end of the barbell and a 15 kg plate on the other end of the barbell. The barbell is 2.2 m long and has a mass of 20 kg without the plates on it. The 20 kg plate is located 40 cm from the right end of the barbell, and the 15 kg plate is located 40 cm from the left end of the barbell. Locate the center of gravity of the barbell with the weight plates on it? Also, draw the free body diagram.
 - (c) (i) What is the significance of pre-stretch in a muscle which has to produce contractile force?
 - (ii) Differentiate slow-twitch muscle fibers from fast-twitch muscle fibers.
- **3.** (a) (i) How much strain energy is stored in a tendon that is stretched 5 mm, if the stiffness of 2+4 the tendon is 10,000 N/m?

(ii) A diver weighing 60 kg has an angular velocity of 6 rad/sec about the transverse axis when he leaves the board in a layout position. When the person undergoes tuck position, the angular velocity increases to 24 rad/sec. If the person's moment of inertia is 15 kg.m² in the layout position, what is the person's radius of gyration in the tuck position?

- (b) How do you explain the non-linear phase in the force-deformation curve for tendon and 6 ligament?
- (c) Explain the biomechanics of cortical and trabecular bone.
- 4. (a) (i) The hand exerts a force of 90 N at a distance of 32 cm from the center of the elbow 2+4 joint. The triceps is attached to the ulna at an angle of 90° and at a distance of 3 cm from the center of elbow joint. The weight of the forearm & hand is 40N with their center of gravity located at a distance of 17 cm from the center of elbow joint. How much force is being generated by the triceps in order to maintain that static position? Also, draw the free body diagram.

(ii) The end portion of the shafts of two prosthetic legs have exactly the same surface area in cross-section, but the body of the shaft of leg A has a diameter 2% smaller than that of leg B. The two shafts are made from the same material.

- a) Under a uniaxial tensile load, which shaft is stronger?
- b) Under a uniaxial compressive load, which shaft is stronger?
- c) Under a torsional load, which shaft is stronger?
- d) Under a bending load, which shaft is stronger?
- (b) Explain the floating ability of human body.
- (c) (i) How does peroneus longus muscle act as a pulley system in the human body and what 4+4 kind of movement does it lead to?

(ii) With clear illustrations, show how the translational kinetic energy varies during different phases of a gait cycle.

- 5. (a) Explain the effect of centripetal force when a person has to run along the curve of a **6** running track. Also provide the details of changes that need to be made in the movement while running along the curve.
 - (b) (i) A "squat" is a weight lifting exercise that begins while standing upright with a barbell 2+4 supported on the shoulders. The knees are flexed and then extended, trying to keep the back fairly straight upright. In terms of torque, moment arm and muscle force, why is it difficult to do a "deep squat" compare to a "half squat" in which you squat down partly before rising?

(ii) How does the joint angle affect the torque production capabilities of a muscle crossing that joint?

(c) (i) A person runs a 400 m race around a 400 m track. On the backstretch, his velocity is 8 2+6 m/s, but he runs against the headwind of 2 m/s. How large is the drag force that acts on him? Assume that the density of air is 1.2 kg/m^3 , the person's cross-sectional area is 0.5 m^2 and the coefficient of drag is 1.1.

(ii) Draw necessary figures to show the significance of angle of attack in non-wing shaped objects and also explain it.

8

6