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# MANIPAL INSTITUTE OF TECHNOLOGY

**(A constituent unit of MAHE, Manipal 576104)**

**I SEM M.Tech (BME) DEGREE END SEMESTER EXAMINATIONS NOV/DEC 2018**
**SUBJECT: BIOMECHANICS &BIODYNAMICS (BME 5104)**
(REVISED CREDIT SYSTEM)
**Tuesday, 27th November 2018: 2 PM to 5 PM**

**TIME: 3 HOURS** **MAX. MARKS: 50**

**Instructions to Candidates:**

1. **Answer all questions.**
2. **Draw labeled diagram wherever necessary.**

1A. Describe all the movements that the wrist joint is capable of performing in different planes of movement. 05

1B. What are the design requirements for a bone? Provide an example to explain how certain bones in human body are designed primarily to accelerate the speed of movement with minimal energy expenditure. 05

2A. A person is holding a dumbbell and the arm whose length is 50 cm is flexed to $60^{o}$ from the reference position. Calculate the length of moment arm between the dumbbell and the shoulder joint? Also, draw the free body diagram. 03

2B. At what percentage of resting length of the skeletal muscle, maximum contractile force can be generated? Write about at-least five factors that are responsible for increasing the muscle contractile force. 03

2C. Draw the graph (force vs. velocity) representing the types of muscle tension and also explain it. 04

3A. At the instant of takeoff, a 60 kg diver's angular momentum about his transverse axis is 20 $kg.m^2/s$. His radius of gyration about the transverse axis is 1.0 m at this instant. During the dive, the diver tucks and reduces his radius of gyration about the transverse axis to 0.5 m. 03

(i) At takeoff, what is the diver's angular velocity about the transverse axis?

(ii) After the diver tucks, what is his angular velocity about the transverse axis?

(iii) What do you infer from (i) & (ii)?

3B. Draw the curves representing the vertical GRF of a runner in case of heel-striker and mid-foot striker. Explain their difference and the factors that affect them. 03

3C. With an example of elbow flexion and extension, explain how muscle power varies due to changes that occur w.r.t. elbow joint torque and angular velocity. 04

4A. A punter kicks a football with a resultant velocity of 18 m/s at an angle of 48°. The ball leaves the foot at a height of 0.8 m. If the ball experiences a constant vertical acceleration of $-9.8\,m/s^2$ while it is in the air, what will the ball's position be after 1.5 s from the ground? 03

4B. With an example, explain the effects of torque applied over a distance. 03

4C. A person is holding a 100 N weight in his hand. The weight is at a distance of 0.3 meters from the center of rotation of elbow. 04

(i) If the forearm is parallel to the ground, what is the torque about the elbow due to the weight?

(ii) If that torque is counteracted by the biceps muscle acting with a moment arm of 2.5 cm, what is the force of that biceps muscle?

(iii) If the triceps muscle (an elbow extensor) is co-contracting and exerting a force of 1000 N, how would that quantitatively affect the biceps force needed to keep the elbow stationary? Moment arm of triceps is 0.04 m.

Also draw the free body diagram.

5A. Calculate the drag force acting on a 105 kg (including the bicycle) cyclist moving at 10 m/s, at 20 m/s and at 30 m/s. Use a drag coefficient of 0.8, a frontal surface area of 1.0 $m^2$, and a density of 1.0 $kg/m^3$. 03

5B. Diagrammatically show and explain how lift force can be generated in a discus-shaped object. Also explain how the object might undergo stalling before completing its trajectory. 03

5C. If a person has to float naturally or conditionally, what are the characteristics that are required to float efficiently in both the cases mentioned above. 04