U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 20ME5DEBHM **Max Marks: 100**
Course: Biomechanics of Human Movement **Date: 07.03.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.

UNIT - I

1 Define walking speed as the center-of-mass velocity in the fore–aft direction. Steady-state walking is thought of as a state in which walking speed is constant. In reality, walking speed fluctuates slightly throughout the gait cycle, but during steady-state walking, the net change in walking speed from the beginning to the end of the gait cycle is zero. **20**

(i) For steady-state walking, sketch the vertical and horizontal ground reaction force components as functions of percent gait cycle. Which of these plots can be used to directly compute the fluctuations in horizontal velocity over the gait cycle?

(ii) On the relevant ground reaction force plot from part (a), label the following: (i) when walking speed is increasing, (ii) when walking speed is decreasing, (iii) when walking speed reaches a maximum, and (iv) when walking speed reaches a minimum. Please explain your answers. To simplify the problem, you may focus your analysis on the ground reaction forces acting on a single limb (i.e., ignore the ground reaction forces from the contralateral limb during double-support).

(iii) How do the timings of increasing and decreasing walking speed you identified in part (b) compare to what you would expect from a simple, inverted-pendulum model of walking?

(iv) Re-sketch the steady-state walking horizontal ground reaction force as a function of percent gait cycle. On this plot, sketch how you would expect the horizontal ground reaction force to change in the following conditions: (i) the person was speeding up, and (ii) the person was slowing down.

UNIT - II

2 a) Draw the active force-length, passive force-length, total force-length, force-velocity, power-velocity and tendon force-length curves and describe them briefly. In the active force-length curve, show the sarcomere configuration corresponding to each section of the curve. In passive force-length curve, show the configuration of titin corresponding to the sections of the curve. **15**

	b)	Draw the schematic of the Hill Muscle Model and label it.	**05**

OR

3		With neat sketches explain the cross bridge cycle and the sliding filament theory of muscular contraction	**20**

UNIT - III

4	a)	List and briefly discuss on the applications of human motion measurement.	**08**
	b)	Derive the transformation matrix that relates the tibia reference frame relative to the femur reference frame in terms of transforms relating different anatomical and tracking reference frames. Mention the known constant transforms and time varying transforms and also mention how they are known.	**12**

UNIT - IV

5		Consider a planar model of squatting. Assume that both sides of the legs can be combined into a single side. Also assume that the foot is stationary. Assume that the ground reaction forces are measured and the mass and moment of inertia about center of mass, the lengths of the segments and the position of center of mass of the foot, shank, thigh and HAT segments are known. Draw the free body diagram of all the segments and solve for the forces and moments at the ankle, knee, and hip joints.	**20**

OR

6	a)	Why muscle forces have to be solved by optimization?	**02**
	b)	What are the two classes of problems solved in muscle force optimization? Describe them briefly.	**06**
	c)	What is dynamic optimization in the context of musculoskeletal simulation? Explain the dynamic optimization procedure with a flow chart. Include the details of the forward simulation workflow within the flowchart.	**12**

UNIT - V

7		Depict the stages involved in muscle driven simulation and discuss them in detail.	**20**

******