INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Date: 19-02-2015 (AN) **Spring Mid-Semester 2015** **Time:** 2 hrs **Full Marks:** 60

Department: **Mechanical Engineering** Subject: **Mechanics of Human Body** Subject No: **ME 60430**

Marks distribution for each question is indicated within brackets.
Assume any suitable data that may be required for solution, stating clear justifications

Answer all questions.

(1) (a) What is meant by 'Gait Cycle'? What are the different phases of gait cycle.

(b) Using a graphical representation, explain the variation of hip-joint reaction force during a gait cycle. What are the peak values of hip-joint reaction forces in terms of body weight for normal walking and stair climbing?

(8 + 7 = 15)

(2) (a) What are the joints and bones that constitute a 'Knee Joint'? Name the major muscles, ligaments and tendons in the knee joint.

(b) What are the biomechanical functions of the 'Patella' in the knee joint?

(c) Indicate the basic musculoskeletal loading with points of application of forces acting on a proximal femur using a 'free body diagram'.

(d) Briefly describe the principle of 'Inverse Dynamics' and state how it is applicable for biomechanical simulation to estimate musculoskeletal forces.

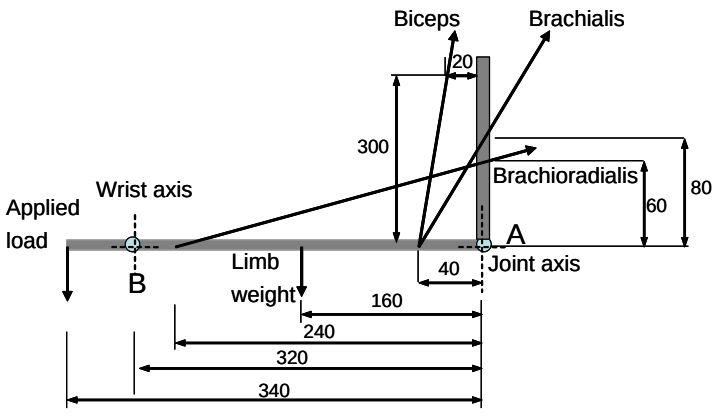
(5 + 3 + 3 + 4 = 15)

(3) A subject carries a sack of weight 120 N with an elbow flexed at 90^o and hands in a neutral position of rotation. The distances of the points of action of the forces on the forearm and on the humerus from axis *A* are shown in *Figure 1*. Cross-sectional areas of the muscles are:
(i) $A_{Biceps} = 500\ mm^2$
(ii) $A_{Brachialis} = 480\ mm^2$
(iii) $A_{Brachioradialis} = 100\ mm^2$

Assuming all the three muscles are stressed to the same intensity, find:

(a) Forces produced in each muscle.
(b) Force imposed by the ligamenteous system
(c) Humero-radial joint reaction force, assuming that the combined component of the ligaments acts at 80 mm from the joint axis along the radial shaft.

(6 + 3 + 6 = 15)



All dimensions are in mm

Figure 1

(4) (a) What are the joints and bones that constitute a shoulder girdle?

(b) What are the joints and bones that constitute the elbow joint? Name the movements offered by the elbow joint.

(c) Name the muscles that constitute the 'rotator cuff'. What are the functions of 'rotator cuff muscles'?

(d) Calculate the total number of degrees of freedom of the shoulder girdle, citing justifications.

(3 + 4 + 4 + 4 = 15)