**INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR**

**Date:** 20-02-2017 (AN)    **Spring Mid-Semester 2017**    **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)** Briefly describe the principle of 'Inverse Dynamics' method along with the mathematical formulation. Considering a limb segment, state how this method is useful in calculating musculoskeletal forces.

*(7 + 8 = 15)*

**(2) (a)** What are the differences between cartilaginous and synovial joints? Name few joints of each type.

**(b)** What are the joints and bones that constitute a 'Knee Joint'?

**(c)** Name the major muscles, ligaments and tendons of the 'Hip Joint'.

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

*(4 + 3 + 4 + 4 = 15)*

**(3) (a)** What are the range of movements offered by the elbow joint and the major muscles responsible for these movements?

**(b)** What are the joints and bones that constitute a shoulder girdle? Name the muscles that constitute the 'rotator cuff' and state its function.

**(c)** Indicate the lines of action of major muscles and joint reaction force acting on the femur, using a free body diagram.

*(6 + 5 + 4 = 15)*

**(4)** A subject carries a sack of weight 100 N with an elbow flexed at 90° 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*.
Take limb weight = 20 N
Cross-sectional areas of the muscles are:
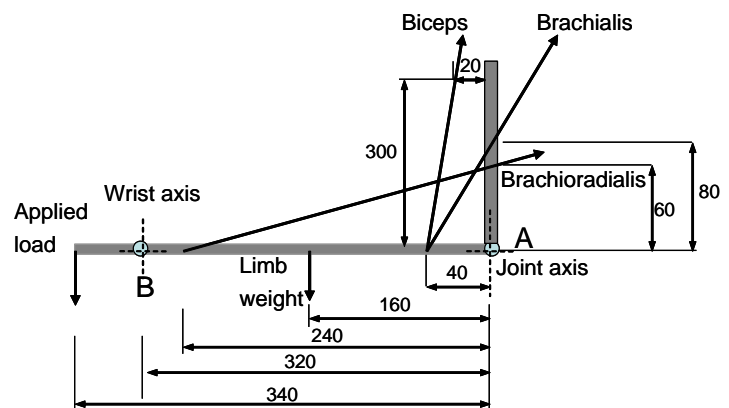*(i)* $A_{Biceps} = 480\ mm^2$
*(ii)* $A_{Brachialis} = 450\ mm^2$
*(iii)* $A_{Brachioradialis} = 80\ mm^2$

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

**(a)** Forces produced in each muscle.
**(b)** Force imposed by the ligamentous 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.

*All dimensions are in mm*

**Figure 1**

*(6 + 3 + 6 = 15)*