**pINDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR**

**Date:** 20-02-2014 (AN) **Spring Mid-Semester 2014 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 are the joints and bones that constitute a shoulder girdle?

**(b)** What are the range of movements offered by the shoulder joint and the names of the major muscles responsible for these movements?

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

**(d)** Name the muscles that constitute the ‘rotator cuff’. What are the functions of ‘rotator cuff muscles’?

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

**(2) (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?

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

*(5 + 5 + 5 = 15)*

**(3) (a)** What are the joints and bones that constitute a ‘Knee Joint’?

**(b)** Using a simple sketch, indicate clearly the action of musculoskeletal forces on the knee joint.

**(c)** What are the biomechanical functions of the ‘Patella’ in the knee joint?

**(d)** Explain the principle of ‘Inverse Dynamics’ and state how it is applicable for biomechanical simulation to estimate musculoskeletal forces.

*(3 + 4 + 3 + 5 = 15)*

**(4)** A subject carries a sack of weight 100 N with an elbow flexed at 90o 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) ABiceps = 540 mm2 (ii) ABrachialis = 520 mm(iii) ABrachioradialis = 130 2*

*mm2*

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

**(a)** Forces produced in each muscle. **(b)** Humero-ulnar joint reaction force. *(8 + 7 = 15)*

Biceps Brachialis Limb weight

Biceps Brachialis Limb weight

20 20

300 300

Applied Applied

Wrist Wrist axis axis

load load

Brachioradialis Brachioradialis

60 60 80 80

A A 40 40

160 160 240 240

340 340

*All All dimensions dimensions are are in in mm mm* B B

Joint Joint axis axis

320 320

**Figure 1**