

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'? Explain with the help of a suitable diagram, the different phases of a gait cycle.

(b) With the help of a graphical representation, explain the variation of hip-joint reaction force during a normal walking 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 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) A weight of 50 N is held in hand at an abduction angle of 90 degrees (Fig. 2). Assume a weight of 25 N for the entire arm and its centre of mass located at 300 mm from the center of the scapulo-humeral joint along a line from the center of the shoulder joint to the center of the wrist. Also assume that the weight of 50 N is acting at a point along the same line at a distance of 500 mm from the scapulo-humeral joint.

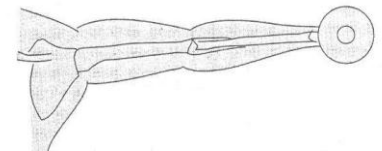


Figure 2

Using 2-D static analysis and considering shoulder muscle forces F_1 , F_2 , ..., F_n , indicate the steps to calculate the shoulder-joint reaction force to sustain the weight held in hand.

(3 + 5 + 7 = 15)

(3) A subject carries a sack of weight 250 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 3. Cross-sectional areas of the muscles are:

(i) $A_{\text{Biceps}} = 520 \text{ mm}^2$

(ii) $A_{\text{Brachialis}} = 500 \text{ mm}^2$

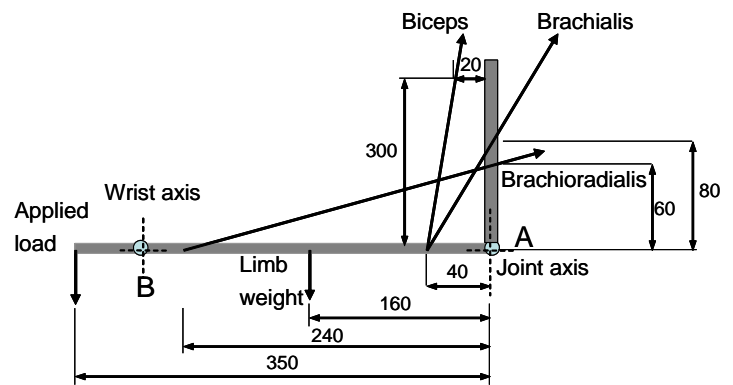
(iii) $A_{\text{Brachioradialis}} = 120 \text{ mm}^2$

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

(a) Forces produced in each muscle.

(b) Humero-radial joint reaction force.

(8 + 7 = 15)



All dimensions are in mm

Figure 3

(4) (a) What are the range of movements offered by the hip joint?

(b) Using a free body diagram, indicate the action of major muscle and joint reaction forces acting on the femur during a single-leg stance.

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

(4 + 6 + 5 = 15)