ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2016 SESSION

Open-book examination
Calculators : Only authorized models
Duration : 3 hours

14-IN-B2 Ergonomics

1) A workstation will be used for coarse assembly work, by men and women, in sitting or standing postures. Determine, **using the anthropometric data provided in appendix**:

   a) The fixed height of the table, considering that the workers' hands are 11 cm above the work surface during the assembly operations. (5 pts)

   b) The minimum and maximum height of the adjustable work seat (5 pts)

   c) The minimum and maximum height of the adjustable footrest (5 pts)

   d) If a monitor screen was used, what should be the minimum and maximum height of its center, considering a 57 cm reading distance (5 pts)

2) A task carried out for 12 hours requires an energy expenditure estimated at 1.9 Kcal/min. Is this task acceptable for a 45 years old female worker with an average fitness level and weighing 60 Kg? (10 pts)

3) In what situations is it appropriate to consider the use of a sit-stand workstation? (5 pts)

4) True of False? (10 pts)

   a) When the reflectance of the background of the visual field is low, it is recommended to increase the illuminance of the visual task?

   b) For a given physical task, the energy expenditure of a 70 Kg man is much higher than for a 70 Kg woman?

   c) According to the NIOSH, a compression effort under 6400 N at the L5/S1 level is acceptable to 75% of women and 99% of men?

   d) With a low control/response ratio, fine adjustments are more difficult?

5) Three controls must be installed on a microscope: focus control, intensity of lighting control and adjustment of contrast. Discuss the advantages and disadvantages of the different coding methods for identification of controls that would be adequate in this application. (10 pts)

6) A warehouse was recently transformed into an open office space with many desks. However, employees complain of a glare problem caused by the existing light fixtures. Discuss the potential causes of this problem and the solutions that could be considered. (10 pts)

7) Discuss the impacts, from an ergonomic point of view, of wearing gloves for industrial work. (5 pts)

8) Discuss the different factors that can influence visual acuity. (5 pts)

9) An operator must remove parts produced by a machine at a pace of 5 parts per minute. He grabs the parts (by the sides, with the hands in the middle) at 108 cm from the ground. He then puts them down on a conveyor at 72 cm from the ground. In order to make sure that the parts are well in place on the conveyor, they must be guided onto a special support as they are set down. Parts dimensions are 42 cm x 42 cm x 42 cm. This task is carried out for 7 hours. Using the NIOSH 1994 Manual Lifting Guidelines (equation provided below), determine the RWL for this task. State your assumptions as needed. (15 pts)

RWL (Kg) = 23 (HM) (VM) (DM) (AM) (CM) (FM)

- HM (Horizontal Multiplier) = 25 / H where H = cm
- VM (Vertical Multiplier) = (1 - (0.003 |V -75 |)) where V = cm
- DM (Distance Multiplier) = (0.82 + 4.5 / D) where D = cm
- AM (Asymmetry Multiplier) = (1 - (0. 0032 A)) where A = degrees

10) What should be the height of the characters on a sign installed in a relatively dark plant in order to be readable by a 55 years old lift truck driver at a distance of 25 meters? State your assumptions and justify your answer. (10 pts)

Appendix

Anthropometric data

TABLE 1–3. Body Dimensions of U.S. Civilian Adults, Female/Male, in mm

	Percentiles			
	5th	*50th*	*95th*	*SD*
HEIGHTS				
(*f* above floor, *s* above seat)				
Stature ("height")[f]	1,527.8/1,646.9	1,629.4/1,755.8	1,737.3/1,866.5	63.6/66.8
Eye height[f]	1,415.2/1,528.2	1,516.1/1,633.9	1,621.3/1,742.9	62.5/65.7
Shoulder (acromial) height[f]	1,240.9/1,341.6	1,333.6/1,442.5	1,432.0/1,545.6	57.9/62.0
Elbow height[f]	926.3/995.2	997.9/1,072.5	1,074.0/1,152.8	44.8/48.1
Wrist height[f]	727.9/777.9	790.3/846.5	855.1/915.2	38.6/41.5
Crotch height[f]	700.2/764.4	771.4/837.2	845.8/916.4	44.1/46.2
Height (sitting)[s]	795.3/854.5	852.0/913.9	910.2/971.9	34.9/35.6
Eye height (sitting)[s]	684.6/735.0	738.7/792.0	794.3/848.0	33.2/34.2
Shoulder (acromial) height (sitting)[s]	509.1/548.5	555.5/597.8	603.6/646.3	28.6/29.6
Elbow height (sitting)[s]	175.7/184.1	220.5/230.6	264.4/273.7	26.8/27.2
Thigh height (sitting)[s]	140.4/148.6	158.9/168.2	180.2/189.9	12.1/12.6
Knee height (sitting)[f]	474.0/514.4	515.4/558.8	560.2/605.7	26.3/27.9
Popliteal height (sitting)[f]	351.3/394.6	389.4/434.1	429.4/476.3	23.7/24.9
DEPTHS				
Forward reach (to tip of thumb)	676.7/739.2	734.6/800.8	796.7/867.0	36.4/39.2
Buttock–knee distance (sitting)	542.1/569.0	588.9/616.4	639.8/667.4	29.6/29.9
Buttock–popliteal distance (sitting)	440.0/458.1	481.7/500.4	527.7/545.5	26.6/26.6
Elbow–fingertip distance	406.2/447.9	442.9/484.0	482.5/524.2	23.4/23.3
Chest depth	208.6/209.6	239.4/243.2	277.8/280.4	21.1/21.5
BREADTHS				
Forearm–forearm breadth	414.7/477.4	468.5/546.1	528.4/620.6	34.7/43.6
Hip breadth (sitting)	342.5/328.7	384.5/366.8	432.2/411.6	27.2/25.2
HEAD DIMENSIONS				
Head circumference	522.5/542.7	546.2/567.7	570.5/593.5	14.6/15.4
Head breadth	136.6/143.1	144.4/151.7	152.7/160.8	4.9/5.4
Interpupillary breadth	56.6/58.8	62.3/64.7	68.5/71.0	3.6/3.7
FOOT DIMENSIONS				
Foot length	224.4/248.8	244.4/269.7	264.6/292.0	12.2/13.1
Foot breadth	81.6/92.3	89.7/100.6	97.8/109.5	4.9/5.3
Lateral malleolus height[f]	52.3/58.4	60.6/67.1	69.7/76.4	5.3/5.5
HAND DIMENSIONS				
Circumference, metacarpal	172.5/198.5	186.2/213.8	200.3/230.3	8.5/9.7
Hand length	165.0/178.7	180.5/193.8	196.9/210.6	9.7/9.8
Hand breadth, metacarpal	73.4/83.6	79.4/90.4	85.6/97.6	3.8/4.2
Thumb breadth, interphalangeal	18.6/21.9	20.7/24.1	22.9/26.5	1.3/1.4
WEIGHT (in kg)	39.2*/57.7*	62.0/78.5	84.8*/99.3*	13.8*/12.6*

*Estimated (from Kroemer 1981).

Source: Adapted from U.S. Army data reported by Gordon et al. (1989).

Note: In this table, the entries in the 50th-percentile column are actually mean (average) values. The 5th- and 95th-percentile values are from measured, not calculated, data (except for weight). Thus, the values given may be slightly different from those obtained by subtracting 1.65 SD from the mean (50th percentile) or by adding 1.65 SD to it.