20

BSc. Eng. (IPE) Date: 6 October 2023
Semester: 7th Semester Time: 2:30 pm –4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid-Semester Examination Winter Semester, A. Y. 2022-2023
Course No IPE 4705 Time: 1½ Hours
Course Title: Ergonomics and Safety Management Full Marks: 75

There are 3 (Three) questions. Answer all of them. The symbols and abbreviations carry their usual meanings. Marks of each question and corresponding CO and PO are written in the right column. Assume reasonable values if required. Some charts and formulas are provided at the end.

1.	a.	Was ergonomics invented or discovered, or is it just a buzzword for what happens anyway? Briefly discuss the query by providing definition, short history and benefits of ergonomics.	[10] CO1, PO1
	b.	Briefly describe any two steps in anthropomorphic design. In a manufacturing plant, sitting workstations will be used for light assembly. Assume that there is a female population of workers, that the hand is held at elbow height minus 5 cm, and that the hand height above the floor is 55–73 cm covering 5th to 95th percentile. Assume further that the product has a handling height of H/2 cm, where H is the product height. Determine the maximum product height if the worktable is 3 cm thick. If clearance between tabletop and thigh is considered as 2 cm, calculate the height of the tabletop from the floor including shoe height of 3 cm for 5th and 95th percentile.	[2+8] CO2, PO3
	c.	Suppose you want to estimate the sitting height of Chilean bus drivers, but have no data on the anthropometry of the Chilean population. So you are going to use RASH method. In this regard, you would use Brazilian anthropometric data as Argentine body type is similar to the Chilean. From the medical records of Chile, it is found that average stature is 169 cm and standard deviation is 7 cm. While Argentine anthropometric data shows that average stature is 170 cm and standard deviation is 6.6 cm. It also mentions that average sitting height for Argentine is 88 cm and standard deviation is 3.5 cm. Using the above information, find out the estimated 5th and 95th percentile of sitting height of the Chilean bus drivers.	[5] CO2 , P03
2.	a	Write down the stair design guideline and ILO suggested manual lifting techniques with appropriate figures considering ergonomics.	[10] CO1 , PO1
	b	Explain the limitations of NIOSH equation on manual lifting. A worker has to unload trays of beef pie weighs 12 kg as they emerge from an oven. He picks up a tray, turns 45 degrees and places it on a conveyor. He does this 3 times per minute for 8 hours. You have been asked to investigate the task and have taken the following measurements with a tape measure. Distance from the midpoint of the body is 45 cm, Height of hands above floor is 60 cm, distance of conveyor to oven is 70 cm, estimated angle of asymmetry by visual inspection is 45 degree. Use the NIOSH equation to calculate the RWL(Recommended Weight Limit) and the lifting index (LI). Also suggest any two ways to reduce LI.	[15] CO2 , PO3
3.	a	Illustrate the biomechanics of manual handling with appropriate figures. If a person is going to lift a 250 Newton Object manually by moving the upper body part forward, find out the compressive force, shear force and muscle force working as per biomechanics in the lower back zone of the body by assuming reasonable values as required.	[6+7] CO2 , PO3
	b	Explain ergonomics principles of reflections and glare, monitor position, ideal posture and handle in relation to VDT(Visual Display Terminal) design.	[12]

----0000----

Table 6.11 1991 NIOSH lifting equation

RWL = LC × HM × VM × DM × AM × FM × CM

LC = load constant of 23 kg
HM = horizontal multiplier = (25/*H*)
VM = vertical multiplier = 1 − (0.003|*V* − 75|)
DM = distance multiplier = 0.82 + (4.5/*D*)
AM = asymmetric multiplier = 1 − (0.0032*A*)
FM = frequency multiplier (from Table 6.12)
CM = coupling multiplier (from Table 6.13)

where

H = horizontal distance of the hands from midpoint (0) of the ankles
V = vertical distance of the hands from the floor
D = distance through which the load is lifted
A = angle of asymmetry (Figure 6.4)
F = frequency of lifting (lifts/min every 1, 2 or 8 hours)

Table 6.13 Values of coupling multiplier CM for use in the 1991 NIOSH equation for determining RWL

Coupling	V < 75 cm	V ≥ 75 cm
Good	1.00	1.00
Fair	0.95	0.95
Poor	0.90	0.90

Table 6.12 Values of frequency multiplier FM for use in the 1991 NIOSH equation for determining RWL

	Work duration					
	≤ 1 hour		*≤ 2 hours*		*≤ 8 hours*	
Frequency (lifts/min)	*V < 75*	*V < 75*	*V < 75*	*V < 75*	*V < 75*	*V < 75*
0.2	1.00	1.00	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.81	0.81
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.80	0.80	0.60	0.60	0.35	0.35
6	0.75	0.75	0.50	0.50	0.27	0.27
7	0.70	0.70	0.42	0.42	0.22	0.22
8	0.60	0.60	0.35	0.35	0.18	0.18
9	0.52	0.52	0.30	0.30	0.00	0.15
10	0.45	0.45	0.26	0.26	0.00	0.13
11	0.41	0.41	0.00	0.23	0.00	0.00
12	0.37	0.37	0.00	0.21	0.00	0.00
13	0.00	0.34	0.00	0.00	0.00	0.00
14	0.00	0.31	0.00	0.00	0.00	0.00
15	0.00	0.28	0.00	0.00	0.00	0.00
>15	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 8.3
U.S. Civilian Body Dimensions in cm of Relevance for Workplace Design

	Female			Male		
	5th	50th	95th	5th	50th	95th
Standing						
1. Tibial height	38.1	42.0	46.0	41.0	45.6	50.2
2. Knuckle height	64.3	70.2	75.9	69.8	75.4	80.4
3. Elbow height	93.6	101.9	108.8	100.0	109.9	119.0
4. Shoulder (acromion) height	121.1	131.1	141.9	132.3	142.8	152.4
5. Stature	149.5	160.5	171.3	161.8	173.6	184.4
6. Functional overhead reach	185.0	199.2	213.4	195.6	209.6	223.6
Sitting						
7. Functional forward reach	64.0	71.0	79.0	76.3	82.5	88.3
8. Buttock–knee depth	51.8	56.9	62.5	54.0	59.4	64.2
9. Buttock–popliteal depth	43.0	48.1	53.5	44.2	49.5	54.8
10. Popliteal height	35.5	39.8	44.3	39.2	44.2	48.8
11. Thigh clearance	10.6	13.7	17.5	11.4	14.4	17.7
12. Sitting elbow height	18.1	23.3	28.1	19.0	24.3	29.4
13. Sitting eye height	67.5	73.7	78.5	72.6	78.6	84.4
14. Sitting height	78.2	85.0	90.7	84.2	90.6	96.7
15. Hip breadth	31.2	36.4	43.7	30.8	35.4	40.6
16. Elbow-to-elbow breadth	31.5	38.4	49.1	35.0	41.7	50.6
Other dimensions						
17. Grip breadth, inside diameter	4.0	4.3	4.6	4.2	4.8	5.2
18. Interpupillary distance	5.1	5.8	6.5	5.5	6.2	6.8

Adapted from McConville et al. (1981). 1 in. = 2.54 cm. Measurements are in cm with bare feet; add 3 cm to correct for shoes.