National Exams Dec. 2015

98-Ind-B5, Ergonomics

3 hours duration

Instructions:

- There are seven (7) pages to this exam with three parts and a total of five (5) questions. You must answer a total of 4 questions (Part A, **and** two other questions from part B, **and** part C).
- The NIOSH tables are produced at the end of this exam for your use.
- This is an open book exam; all notes, books and non-communicating calculator is permitted.
- **Please use point form to answer all questions.**
- If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made;
- Any non-communicating calculator is permitted.
- No pagers, cellular telephones, smartphones or other communication devices are permitted in this exam.

Marking Scheme

Question Number	*Total Possible*	*Grade*
Part A: General - mandatory	25 marks	
Part B: Choose 2 questions to answer from questions 2-4. Do not answer all three questions		
2.	20 marks	
3.	20 marks	
4.	20 marks	
Part C: Case Study - Mandatory	35 marks	
Total	**100 marks**	

Part A: Mandatory

25 marks] 1. You are working for an ice cream and sorbet making company that wants to modernize its control and display panels for its mixing stations. At the mixing stations the liquid ice cream mixture is poured into large cooled mixing vats. A mixer arm is lowered into the vat and rotated at 20 rpm until the ice cream is the appropriate density/thickness. In order for the ice cream mixture to thicken, the vat must be maintained at a temperature of -5°C. However, in order for the ice cream to be packaged it must be soft and fluid enough to be pressed through a 3 cm nozzle (not completely frozen but not a liquid). Careful monitoring, timing and control are required to accomplish the making and packaging of the ice cream products. The old system used only analogue controls (mechanical buttons and knobs), lights and dials. Controls and displays are required for monitoring, increasing/decreasing, and setting the following variables: temperature, pressure, volume, inflow/outflow, and density of the ice cream mix as well as the temperature and speed of the mixing arms and vats.

[15] Provide a design recommendation for the new control system and justify your reasoning. Ensure that you include a drawing of your recommendations.

[10] Explain the main components of the human perceptual and cognitive system that would be involved in monitoring and manipulating this control and display system.

Part B: Choose two questions to answer from questions 2-4.

[20 marks] 2. A worker must unload trays of pizzas (diameter = 20 cm) as they emerge from an oven. He picks up a tray directly in front of him, turns 45° to one side and places the tray on a conveyor. A full tray of pizzas weighs 12 kg. He does this 4 times per minute for 8 hours. You have been asked to investigate the task and have taken the following measurements with a tape measure.

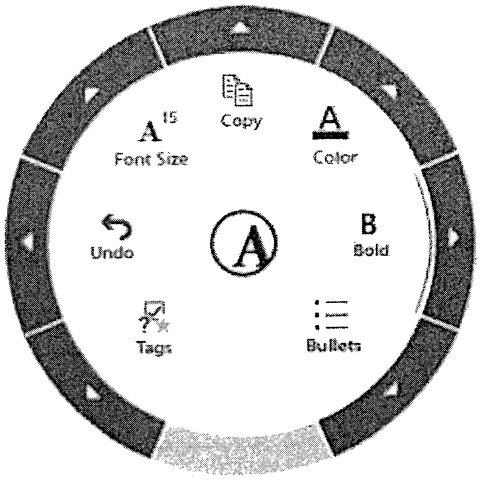
The distance of the load from the mid-point of the body is = 50 cm, height of the hands above the floor = 60 cm; distance through which the load is lifted = 60 cm. Use the tables provided with this exam.

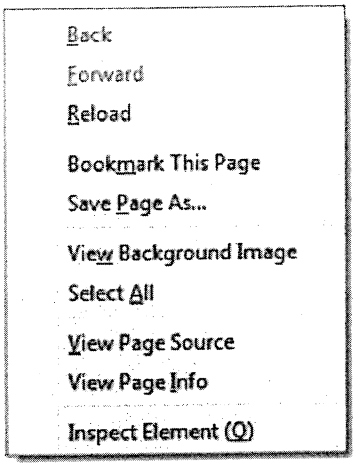
a. [5] Calculate the Recommended Weight Limit and Lifting Index for this task using the NIOSH formula. Justify your assumption for the coding multiplier.
b. [5] Is this task safe? What are the risk factors for a worker performing this task (e.g., what injuries might this worker incur)?
c. [15] Explain the advantages and disadvantages for at three different solutions for making this task safer? Show the new RWL for solutions where appropriate.

20 marks] 3. Ergonomics checklists, such as are the Computer Workstation Ergonomics Checklist, are a common method of analysing the ergonomics of a particular workplace.

a. [10] Explain the main elements of such ergonomics checklists and how they can be used effectively in assessing ergonomics issues.
b. [10] What are the pitfalls of relying on checklists when performing an ergonomics assessment. Explain other techniques that can be used for assessing ergonomics issues in workplaces?

[20 marks] 4. Explain Fitts' Law and Hicks' Law for designing software interfaces. Which menu type shown below does Fitts' Law suggest is preferable and why? Which menu does Hick's Law prefer and why?





[35 marks] Part C: Case study

You have been asked to advise a large grocery chain on how to reduce the number of back, neck and arm/wrist strains that cashiers are experiencing and complaining about. They also want to reduce the number of mistakes cashiers are making due to incorrect entry of food codes, and scanning errors. During an eight-hour shift, cashiers are required to stand with both feet on the ground at a conveyer belt/counter that is 87 cm above the floor (recommended standard) to process groceries by dragging items across a bar code scanner or weigh scale located at the end of a conveyor belt where the customer places groceries. The cashier must also type in codes for weighed items using a keyboard placed at a height of 128 cm above the floor (according to standards). The cashier must twist 90° from the conveyer belt/scanner to access the cash and receipt drawer that is placed at a level slightly lower than the conveyer belt. There are two 15 minutes breaks and a one hour lunch break where the person can sit down. Cashier demographics include: standing stature ranging between 150 - 200 cm, weight between 50 – 100 kg, age range between 18 and 65 years, and it is a mostly female work force.

Assume that you have a fairly limited budget and that the owner of the grocery is <u>not</u> considering "self check out" solutions.

a. [8] Describe the types of manual materials handling tasks that cashiers would be carrying out.
b. [10] Provide recommendations on physical ergonomic accommodations that would be suitable for the cashiers. Justify your recommendations and provide the appropriate anthropometric data that is appropriate for use with this design. Provide a sketch of an example workstation and label the dimensions (including any required ranges of adjustment). Indicate on your sketch the population proportion that you believe will be satisfactorily accommodated by these dimensions. The manager would like to begin to accommodate workers in wheelchairs. What adjustments would you make to the cashier's workstation to make these accommodations?
c. [10] Provide recommendations on other factors that would assist in reducing the number of errors made and strain injuries occurring, and increase the comfort/task performance of the cashiers. Identify the important variables to measure/track for each condition and how these are measured (e.g., instruments used, units of each variable). Specify how to determine the appropriate level of each condition for this workplace that would minimize the number of entry errors. How would you ensure that your recommendations provide long term solutions? Provide examples.
d. [10] Describe the evaluation process you would carry out during/after the renovation process to ensure that the accommodations are successful. Ensure that you specify what type of evaluation to use at what time during the renovation. Justify the timing and the methodologies selected.

NIOSH Work Practices Guide to Manual Handling Formula Multipliers

These formulas eliminate the need for you to do the detailed calculations in the formula:

- ❑ RWL = LC x HM x VM x DM x AM x FM x CM
- ❑ LC is 23kg or 51 lb.
- ❑ You still need to figure the correct values of H, V, D, A, coupling, etc. and determine the multipliers.
- ❑ LI= Load weight / Recommended Weight Limit = L / RWL Where Load Weight (L) is the object lifted (kg or lb)

Horizontal Multiplier

H	HM	H	HM
in		cm	
≤10	1.00	≤25	1.00
11	.91	28	.89
12	.83	30	.83
13	.77	32	.78
14	.71	34	.74
15	.67	36	.69
16	.63	38	.66
17	.59	40	.63
18	.56	42	.60
19	.53	44	.57
20	.50	46	.54
21	.48	48	.52
22	.46	50	.50
23	.44	52	.48
24	.42	54	.46
25	.40	56	.45
>25	.00	58	.43
		60	.42
		63	.40
		>63	.00

Table 2
Vertical Multiplier

V	VM	V	VM
in		cm	
0	.78	0	.78
5	.81	10	.81
10	.85	20	.84
15	.89	30	.87
20	.93	40	.90
25	.96	50	.93
30	1.00	60	.96
35	.96	70	.99
40	.93	80	.99
45	.89	90	.96
50	.85	100	.93
55	.81	110	.90
60	.78	120	.87
65	.74	130	.84
70	.70	140	.81
>70	.00	150	.78
		160	.75
		170	.72
		175	.70
		>175	.00

Table 3
Distance Multiplier

D	DM	D	DM
in		cm	
≤10	1.00	≤25	1.00
15	.94	40	.93
20	.91	55	.90
25	.89	70	.88
30	.88	85	.87
35	.87	100	.87
40	.87	115	.86
45	.86	130	.86
50	.86	145	.85
55	.85	160	.85
60	.85	175	.85
70	.85	>175	.00
>70	.00		

Table 4
Asymmetric Multiplier

A	AM
deg	
0	1.00
15	.95
30	.90
45	.86
60	.81
75	.76
90	.71
105	.66
120	.62
135	.57
>135	.00

Table 5
Frequency Multiplier Table (FM)

Frequency Lifts/min (F) ‡	Work Duration					
	≤1 Hour		>1 but ≤2 Hours		>2 but ≤8 Hours	
	V < 30†	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

†Values of V are in inches. ‡For lifting less frequently than once per 5 minutes, set F = .2 lifts/minute.

Table 7
Coupling Multiplier

Coupling Type	Coupling Multiplier	
	V< 30 inches (75 cm)	V ≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90