National Exams Dec. 2016

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 which is mandatory and Part B where you chose one of two questions).
- 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 1. 2.	 40 marks 40 marks	
Part B: Choose 1 question to answer from questions 3 or4. Do not answer both questions		
3.	20 marks	
4.	20 marks	
Total	**100 marks**	

Part A: Mandatory

[40 marks] 1. You have been asked to design a training guide and video for manual materials handling procedures for a local courier service where couriers (package delivers) use public buses, subways, trains and streetcars to deliver packages between business in the local area (packages are not delivered to addresses outside of the bus/subway/streetcar range). The normal travel path for a courier would be to pick up a package (box, bag or envelop) and carry it from one location in the city and travel to the nearest bus, subway or streetcar stop, enter the transportation system which may mean using stairs, go to the stop closest to the location for delivery, travel to the destination and drop off the package. Use the NIOSH tables provided.

a) [10] Calculate the recommended weight limit of several different package sizes for a person whose hands are 50 cm above the ground and must walk a maximum distance from a bus stop to a location (for pickup or delivery) of 500 m each way. Consider different angles of symmetry as couriers may need to rest their package on a seat beside them and pick it up again from that seat once they arrive at their desired stop. They may also need to pick up packages from the floor from the sender location. Assume LI should be 1.0. Different package sizes to consider: 1) a box that is 30 cm x 30 cm x 30 cm; and 2) a bag that has a diameter of 25 cm and a height of 40 cm. Use the NIOSH work practices guide. Ensure that you indicate and briefly explain any assumptions you make.

b) [10] Fatigue could be an important issue to consider for this job because there is lifting, walking, and travelling involved. What specific guidelines would you recommend for reducing fatigue problems that could arise?

c) [20] Explain which elements you would include in the training guide (use a table of contents or list format). How would you use video in this training guide; briefly sketch two storyboards of three keyframes each for two different video segments.

[40 marks] 2. You have been asked to carry out a human factors assessment of the CCB Production and Inspection Division of a car assembly plant because the quality of the main control circuit board (CCB) is falling 10% below the target output goal (96% of electronic components must pass the quality control benchmark tests). The board production (soldering all of the electronics onto the main CCB) is an automatic process, however, benchmarking/testing the boards is only partially automated.

The process involves loading 20 different small electronic components (ranging from small resistors occupying about a 50 x 5 mm space to larger integrated circuit (IC) and processor chips of about 30 x 5 mm) into hoppers/bins in order for the robotic mounting system to place and solder these components onto the circuit boards. One of the problems has been that if the components are not loaded into their feeders correctly then they will be mounted backwards resulting in a failure of the CCB. Eight hundred CCBs are produced per eight-hour shift.

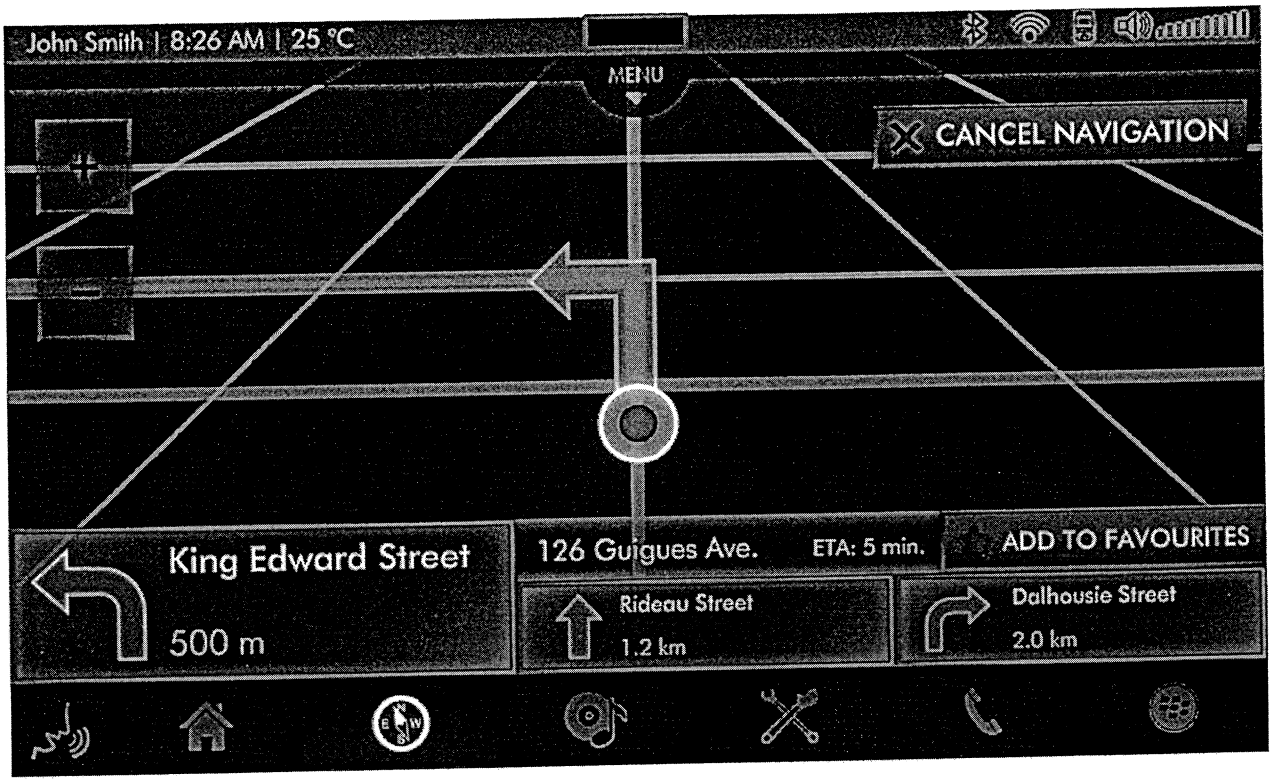
Quality control (QC) workers must ensure that all CCB boards released from the CCB Production and Inspection Division to the Car Assembly Division are functioning properly as well as randomly inspecting selected CCBs for proper placement and soldering of the small components. To inspect a CCB, an automated optical inspection system is used. This system involves automatically comparing the image of a properly assembled CCB to the ones being delivered by the component assembly system. All boards are also automatically placed on a testing port and checked for basic functionality. The boards that are rejected must then be further inspected for faults by QC workers. In addition, human inspectors will randomly select CCBs (4 per hour per person) that have passed the automated inspection process to ensure that the automated process is functioning properly.

Quality control workers have complained that there are a number of problems in their work environment that are causing them to slow down in order to ensure that the CCBs meet the quality standards set by the company. There is, therefore, a speed and accuracy trade-off. Complaints include: a) the pace of the inspection process is too fast and workers feel under pressure to meet the target output goal faster and faster; b) the space they are working in is cramped, hot, noisy and not well lit; and c) some experience back pain by the end of their shift. You have been asked to consult on this problem and determine solutions for the company to consider. Note, the company is also concerned about the cost/benefit issue.

a) [15] Describe the human factors process/approach that you would take to investigate the causes of the complaints in the work environment for the quality assurance workers.
b) [10] What elements of this work environment would you want to examine/measure and why?
c) [5] What human factors/ergonomic standards would you use to evaluate your measures of this environment and why?
d) [10] Explain how a cost/benefit analysis could be used in as an advantage in your approach. Identify 5 costs and 5 human factors benefits that you could use in this analysis. Remember that the company has hired you to increase the percentage of electronic components including CCBs that pass QC inspection.

Part B: Choose one question to answer from questions 3 or 4.

[20 marks] 3. A GPS company has engaged you to assist them in evaluating and updating their human-computer interface. The current one is shown below:



a. [12] Briefly explain <u>two</u> different human factors methods in which you could identify what the issues are? What type of data would you expect to generate from these methods?

b. [8] What human-computer interaction issues do you identify with this interface and why?

[20 marks] 4. Identifying sources of and preventing repetitive strain injuries are important topics in Human Factors and Ergonomics. These types of injuries can be prevalent for many different types of work.

a. [6] Which of the following tasks might cause carpal tunnel syndrome in a worker performing them and why?
   i. Scrubbing debris from a brick wall using a wire brush held in the hand
   ii. Text entry using a computer keyboard
   iii. Painting a ceiling
   iv. Mopping the floor
   v. Playing tennis
   vi. Playing the piano
   vii. Using a jackhammer for breaking up concrete sidewalks during construction.

b. [14] What are other possible strain injury types and risk factors associated with each task in this list.

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