

National Exams May 2009  
Ergonomics – Ind-B5

Name: \_\_\_\_\_

*Instructions:*

- ◆ There are 5 pages to this exam with two (2) parts and a total of five (5) questions and a number of blank pages for answers. You must answer a total of 4 questions (question 1 **and** two other questions from part A and all of part B).
- ◆ Complete all questions on the exam provided. If additional space is required, use the extra pages included with the exam.
- ◆ This is an open book exam; non-communicating calculator is permitted
- ◆ **Answer all questions in the exam. 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, Blackberries or other communication devices are permitted in this exam.

*Marking Scheme*

<i>Question Number</i>	<i>Total Possible</i>	<i>Grade</i>
<b>Part A: General</b>		
1. - mandatory	26 marks	
<b>Choose 2 questions to answer from questions 2-4.</b>		
2.	18 marks	
3.	18 marks	
4	18 marks	
<b>Part B: Case Study - Mandatory</b>	38 marks	
<b>Total</b>	<b>100 marks</b>	

### Part A: Medium Answer Questions.

- [26 marks] 1. You have been asked to design a new ticket dispensing machine for a major public transportation system that includes buses, streetcars, subways, and an intercity railway. The system is to be designed for three possible purchasing options: 1) Ride any time/anywhere/any place – most expensive but most flexible. This type of ticket is transferable but only one person can use it at a time. Also, riders can purchase monthly, weekly or daily versions of this type of ticket. The prices will vary depending on which option is selected; 2) Pay by specific zone and there are four possible zones. In this option, the price of the ticket will depend on the proximity of the zone to the purchaser. For example, if a rider is in zone 1 and wants to get to zone 2, the price is the same as going from zone 2 to zone 3. However, the price for riding from zone 1 to zone 3 (across 2 zones) is more than cost of riding across one zone to its neighbour. Riders can use any mode of transportation with this ticket type. The prices will vary for each zone but will be less expensive than the ride any time ticket; and 3) Purchase a one-way ticket on only one mode of transportation (e.g., bus only) within one zone. This is the least expensive but most restrictive option.

Riders should be able to purchase these tickets with a credit card, a debit card or cash. Once the transaction is complete the rider will receive a printed bar-coded ticket.

- a. [6] Generate a list of typical tasks that users would carry out to purchase a ticket. Include the types of decisions that must be made by the purchaser.
- b. [20] Create a paper mock-up of the control and display system for the ticket. Ensure that you can accommodate as many potential users as possible (e.g., you need alternatives for each control and display). Justify your reasoning for each design decision based on common human factors principals of displays and control types (e.g., if using knobs, knob diameter, turning force, labeling, grouping of controls, etc. should be used in this justification). Explain the population demographics that your system will accommodate.

**Choose two (2) questions from the following questions.**

[18 marks] 2. There are four main types of control resistance, static and coulomb, elastic, viscous and inertial. Explain what control resistance is and why it is important to understand. Explain the characteristics of each different types of control resistances, their advantages and disadvantages. Name and draw an example of a control for each type of control resistance.

[18 marks] 3. Define and explain the differences between flow analysis, task analysis and link analysis. At which point in the design of systems, products or work would these analysis techniques be useful. Justify your answer.

[18 marks] 4. Outline the general principles of computer work station design. Draw and label the elements of a multipurpose station that would allow for basic computer-based and paper-based office work along with the variables that must be adjustable, and the amount of adjustability that should be provided.

**[38 marks] Part B: Design case study**

You have been asked to advise a large and busy restaurant on how to reduce the number of back, neck and arm/wrist strains that their cooks are experiencing and complaining about. They also want to reduce the number of injuries and errors the cooks are making due to incorrect ordering information received from serving staff, handling of very hot solid materials (food, hot liquids such as boiling water, and pots and pans). During an eight-hour shift, cooks are required to stand with both feet on the ground at counters or stoves that are 87 cm high (recommended standard) to process food. Tasks that must be performed include: retrieving food items from various shelves and walk-in refrigerators which have a maximum height of 229 cm, preparing those food items by chopping, cutting, mixing, frying, boiling or baking, removing those items from cooking surfaces and arranging them on serving dishes such as plates or bowls, and placing the serving dishes in an area for the servers to remove them to the customers.

Some food items are stored on shelves that are located in the kitchen but away from the food preparation area. The food stored on these shelves must be retrieved when needed and include flour, sugar, vegetables, meat, sauces, and condiments such as pickles and olives. All of these items stored on the shelves in large industrial containers. Spices and special items that usually fairly light-weight and are used for special menu items are stored on shelves above the food preparation area and the cooks must reach over the food preparation counter to reach those special items. These shelves are located at the back of the food preparation counters at a distance of 55 cm and at a maximum height of 165 cm. Finally, dishes, pots and pans are located under the food preparation areas. The larger, heavier pots (e.g., 12 L Stock Pot) are placed on the lowest shelves.

The cook must also type in codes for finished items so that food can be tracked by a computerized database. The keyboard is placed on a counter that is a height of 128 cm (according to standards). The cooks must often twist between 30 and 90° from the preparation or cooking surfaces to move food, pots, pans and dishes around the cooking surfaces. The temperature in the kitchen on a busy day can increase to above 29C. There are two 15 minutes breaks and a one hour lunch break where the person can sit down.

Cook 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.

- a) [8] Describe the types of manual materials handling tasks that cooks would be carrying out.
- b) [10] Provide recommendations on physical ergonomic accommodations that would be suitable for the cooks. 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 cook's workstations 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 cooks. 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 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.