UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, DECEMBER 18, 2001

MIE343F - INDUSTRIAL ERGONOMICS

Exam Type B

Examiners - Paul White
Tim Pauley

Instructions

This exam is 2.5 hours long. The mark value of each question is indicated in brackets near the question number. You are encouraged to read all the questions through before beginning to write. Budget your time carefully.

You are encouraged to use point form in all of your answers. You are also asked to consider the user of the document that you are about to produce. He is a middie-aged myopic male. You are asked to employ an easily read font of appropriate size and clarity. You are also asked to keep your answers in numerical order in your answer books.

#1 Definitions **(2 marks each, except 3 marks for the last question: total 25 marks)**

Please define the following terms.

Repetitive Strain Injury

2Decibel (dB)

Heat stroke (include cause and symptoms)

Illuminance

Indirect lighting

Power grip (or grasp)

Psychosocial factors in RSI

Wotton test

Psychophysics

Circadian Rhythm

Why do fighter aircraft pilots wear helmets, aside from protecting them from hitting their heads on the cockpit canopy?

2. (10 marks)

What are five important features of a good shift schedule? What should be avoided when designing or administering a shift schedule?

3. (10 marks)

Discuss the advantages and disadvantages of the Snook tables with respect to the NIOSH lifting equation?

4. (15 marks)

Roberta Rubbish-Remover and ten of her friends from Waterloo Systems Engineering have just been hired as summer student replacement workers for Tru-North Trash. Their job is to walk along beside garbage trucks and pick up residential garbage. The metabolic demand for the job has been determined to be "moderate" by a an ergonomist. Tru-North is proud of their black and gold coverall uniforms and insist their workers wear them at all times.

You are the brilliant Skule™ IE student who has a summer engineering job with Tru-North. You have been asked to develop a plan to keep the replacement workers safe from heat-related illness during the summer, particularly during their acclimatization period of 10 working days.

You can assume the weather is going to be hot all summer with an average WBGT of 24.5 °C.

What work-rest schedules will you implement? Show any calculations.

What training will you provide (be specific)? What engineering and/or administrative controls will you implement (be specific)?

5a (5 marks)

Many pamphlets, books and web sites recommend that the appropriate posture for someone seated at a computer work station is: "feet flat on the floor; knees at 90°; upper arms hanging from the shoulders close to the body; elbows at 90° fingers on the home row keys; back upright with lumbar support; head in neutral posture; eyes at rest on the centre of the screen." Is this the advice you would give (or follow)? Explain why or why not with reference to what you have learned this term about how people's bodies work and the principles of workstation design. What would you recommend

5b (5 marks)

What is glare? Why should sources of glare be controlled? What different kinds of glare sources are there?

6. (15 marks)

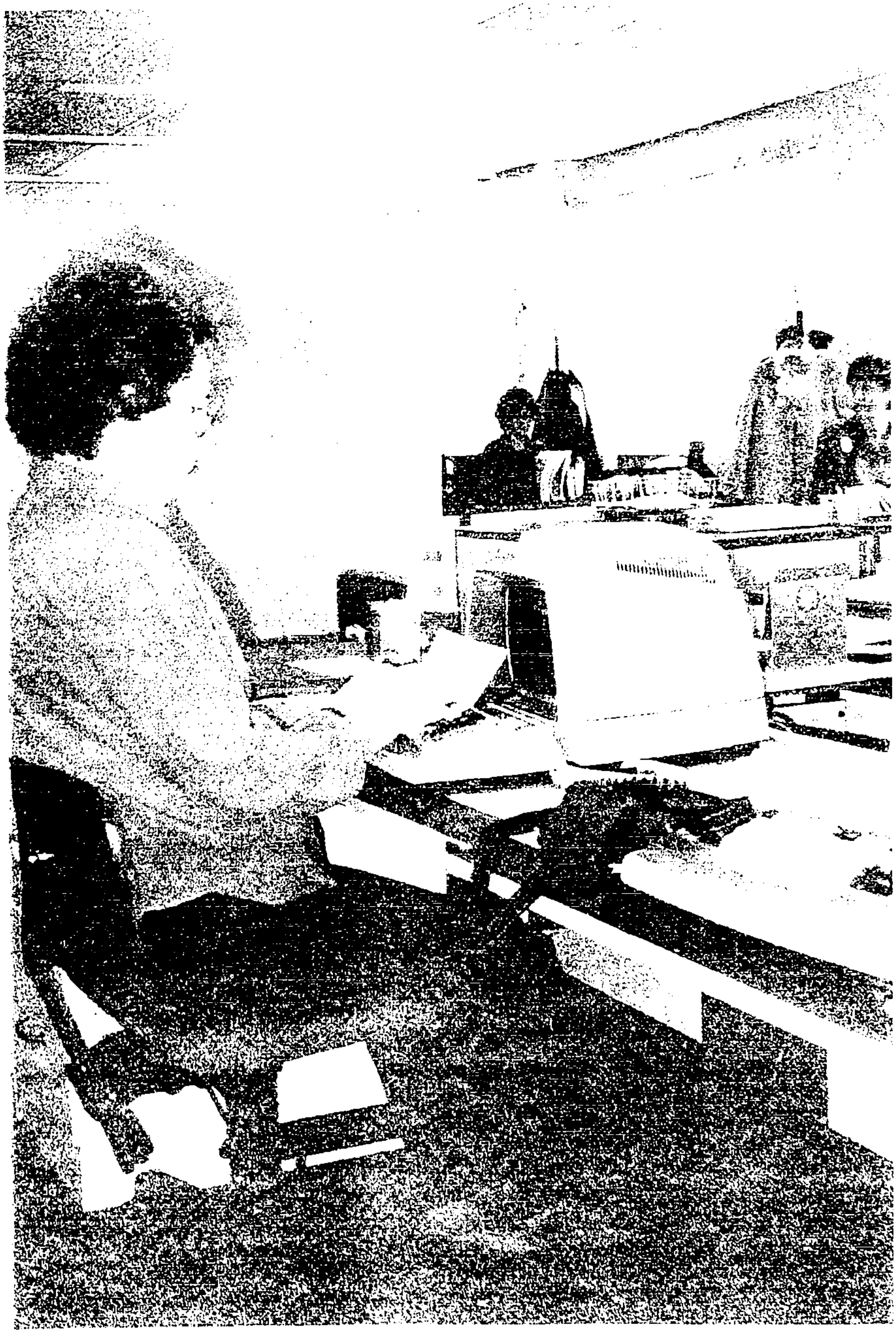
Attached to this exam are three pictures of people at work. The tasks that they are performing represent a substantial percent of their total job time. Indicate what problems or risk factors you can see in the pictures that might cause problems to the worker or to their productivity. If you think one or more injuries might be sustained, indicate what they are. What solutions would you recommend?

7. (10 marks)

We discussed seven corrections (multipliers) that can be applied to values from the Snook tables. Why are corrections to the Snook table required? What problem must we be aware of if we decide to use several correction factors? Name two corrections and indicate why each is necessary based on biomechanical, physiological or anatomical grounds.

8. (5 marks)

Our guest lecturer, Tim Kelsall, indicated that there were 5 main ways to control noise in factories. What are they?



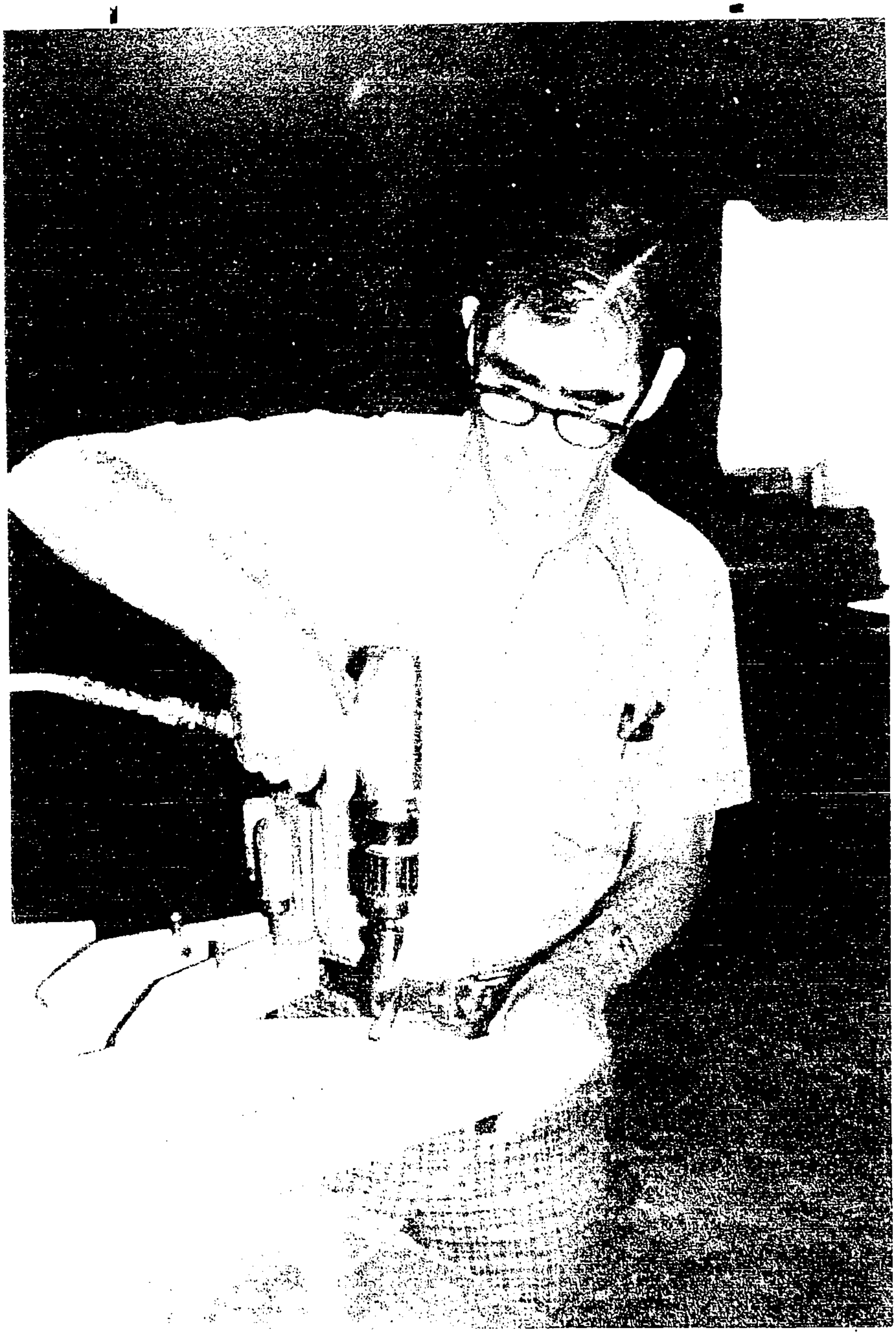


TABLE 1. Examples of Permissible Heat Exposure Threshold Limit Values [Values are given in °C and (°F) WBGT]*

Work–Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous work	30.0 (86)	26.7 (80)	25.0 (77)
75% Work — 25% Rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% Work — 50% Rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% Work — 75% Rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

*As workload increases, the heat stress impact on an unacclimatized worker is exacerbated (see Figure 1). For unacclimatized workers performing a moderate level of work, the permissible heat exposure TLV should be reduced by approximately 2.5°C.

A. The range of the dry and the natural wet-bulb thermometer should be −5°C to +50°C (23°F to 122°F) with an accuracy of ± 0.5°C. The dry bulb thermometer must be shielded from the sun and the other radiant surfaces of the environment without restricting the airflow around the bulb. The wick of the natural wet-bulb thermometer should be kept wet with distilled water for at least 1/2 hour before the temperature reading is made. It is not enough to immerse the other end of the wick into a reservoir of distilled water and wait until the whole wick becomes wet by capillarity. The wick should be wetted by direct application of water from a syringe 1/2 hour before each reading. The wick should extend over the bulb of the thermometer, covering the stem about one additional bulb length. The wick should always be clean and new wicks should be washed before using.

B. A globe thermometer, consisting of a 15-cm (6-inch) diameter hollow copper sphere painted on the outside with a matte black finish or equivalent, should be used. The bulb or sensor of a thermometer (range −5°C to +100°C [23°F to 212°F] with an accuracy of ± 0.5°C)

TABLE 2. TLV WBGT Correction Factors in °C for Clothing

Clothing Type	Clo Value*	WBGT Correction
Summer work uniform	0.6	0
Cotton coveralls	1.0	−2
Winter work uniform	1.4	−4
Water barrier, permeable	1.2	−6

*Clo: Insulation value of clothing. One clo unit = 5.55 kcal/m²/hr of heat exchange by radiation and convection for each °C of temperature difference between the skin and adjusted dry-bulb temperature [the average of the ambient air dry bulb temperature and the mean radiant temperature. $t_{adb} = (t_a + \bar{t}_r)/2$]