Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESI 2020/2021

COURSE NAME	:	HUMAN FACTOR ENGINEERING
COURSE CODE	:	BDD 41103
PROGRAMME	:	BDD
EXAMINATION DATE	:	JUNE 2021
DURATION	:	3 HOURS
INSTRUCTION	:	**SECTION A:** ANSWER **ALL** QUESTIONS. **SECTION B:** ANSWER **FOUR (4)** FROM FIVE (5) QUESTIONS.

THIS PAPER CONSISTS OF **NINE (9)** PAGES

SECTION A

Instruction: Please answer **ALL questions** in this section.

Q1 Sitting for long periods without the opportunity to stand up and move around is another way in which employees are exposed to static loading of tissues, primarily in the lumbar area of the back. It can also affect the upper back, neck and legs. The problem is exacerbated where awkward postures are also present.

Employees may be exposed to static postures when they must sit for a prolonged period on chairs, stools or benches that do not provide adequate lumbar support, that is, either the back rest of the seat does not provide good lumbar support or there is no back rest at all. When there is no lumbar support and the back is bent forward, the muscles of the back are trying to force the lumbar region out of it natural curve (proper alignment of the vertebrae), which places pressure on the discs and reduces blood supply to the spinal tissue. The constant exertion of the contraction forces leads to muscle fatigue.

When the back muscles become sore, people tend to slouch. In this posture more force is being placed on the back and the discs. As the static loading continues, pressure continues to be applied to the membranes of the discs and they may become stressed. Stressed discs, in turn, may put pressure on blood vessels and may pinch a nerve (sciatic nerve), which results in pain.

Even where the chair has a back rest with lumbar support to help maintain the back in a neutral position, employees still may continue to be exposed to static loading because they cannot take advantage of the back rest. This may occur when the seat pan is too big or the seat is too high for the employee. Many employees respond by sitting forward, instead of against the back rest, so that their feet can be on the ground, thus pressing the spine out of the natural curve and placing pressure on the discs.

Because of issues raised due to prolonged sitting mentioned above; as an engineer, you are assigned to foresee these problems and to provide solutions.

(a) Recommend the anthropometrics consideration for the highlighted issues by focusing on usage of anthropometric data. You may refer to anthropometric data provided in Appendix 1.

(16 marks)

(b) Besides of anthropometric interventions, choose one (1) method to analyse and reduce these ergonomic risks.

(4 marks)

SECTION B

Instruction: Please answer **FOUR (4) questions** from FIVE (5) questions provided in this section.

Q2 (a) En. Ahmad is a system analyst at Gading Network Sdn. Bhd. System analysts are responsible for maintaining and improving computer systems for an organisation and its clients. This IT role is growing in popularity and demand as organisations increasingly move operations, processes and communication online. System analysts are often required to work outside standard hours to oversee upgrades or fixes, ensuring there is minimal interruption to business as usual. His work requires him to do analysis and design techniques to solve business problems using information technology; which involve repeated motion patterns and prolonged posture every day at his computer workstation.

(i) Indicate possible occupational injury caused by nature and duration of work.

(2 marks)

(ii) Identify two (2) main risk factors in this working environment that can lead to problem in (i).

(4 marks)

(iii) Based on answer in (i) and (ii), propose two (2) suitable interventions to reduce risk factors.

(4 marks)

(b) Puan Asiah is working at Fujitsama production plant, Parit Raja orkstat 10 years. Last week, she had inflammation on her wrists and more than a week. Medical Officer at Parit Raja Health Clinic was referred her case to Sultanah Aminah Hospital, Johor Bahru and was confirmed she has repetitive strain injury, RSI. As an engineer of occupational, safety and health (OSH), what actions need to be taken in order to overcome the problem? Discuss briefly.

(4 marks)

(c) (i) When is standing workstation is the best alternative?

(2 marks)

(ii) What are the differences between sitting workstation with standing workstation?

(4 marks)

Q3 (a) A new secondary school will be opened in Parit Raja. Department of Education think that this is the right time to reinvent a new environment for this school. Numbers of consultants from few expertise were engaged to look for different aspects. In order to create better environment especially on psychosocial aspects, as an industrial engineer, you are expecting to look for organizational (macro) ergonomics at this school.

(i) Identify at least two (2) relevant scopes which probably may affect the psychosocial aspect in that school

(2 marks)

(ii) Justify why answers in (i) is important to be addressed.

(8 marks)

(b) Currently there are many cases of occupational diseases caused by ergonomics risk factors have been reported to Department of Occupational Safety and Health (DOSH). Indirectly, this will affect labour productivity, profitability and cost of compensations.

(i) What is the appropriate assessment that company or organisation should be conducted for determine these issues?

(2 marks)

(ii) Why the assessment mentioned in (i) is important to be conducted?

(4 marks)

(iii) Identify at least four (4) ergonomics risk factors which may associated to a musculoskeletal injury.

(4 marks)

Q4 (a) Zurina works in printing company at Sri Gading. During her work last Friday, she was exposed to noise to two hour at 80 dBA, three hours at 90 dBA, and two hours at 96 dBA.

The worker is permitted 32 hours for the 80 dBA exposure, 8 hours for the 90 dBA exposure.

(i) Determine the *8-hour TWA* (*time weighted average*) sound level which has been experienced by her.

(4 marks)

(ii) Discuss how to control noise on engineering method.

(4 marks)

(b) Hassan is a worker in production department at Harta Packaging plant, Parit Raja. He is involved in a task which involves occasional box lifting at bench height and above at a rate of F = 6/min. The horizontal location of the box is 38 cm in front of the mid foot position. The vertical distance lifted is 28 cm, and the starting height is 95 cm above the floor.

(i) Calculate the maximum allowable load (kg) which should be lifted, using the revised NIOSH equation (1991) for the Recommended Weight Limit, RWL.

Assume that the total time spent lifting does not exceed one hour/day, the boxes afford a good grip, and the lift is symmetrical.

(4 marks)

(ii) Calculate the maximum allowable load (kg) which should be lifted, using the original NIOSH Action Limit equation.

Assume $F_{max} = 18$

(4 marks)

(d) Manual material handling (MMH) means manually moving or handling things by lifting, lowering, pushing, pulling, carrying, holding or restraining. MMH is also the most common cause of occupational fatigue, low back pain and lower back injuries.

Suggest **FOUR (4)** tasks that makes manual materials handling hazardous?

(4 marks)

Q5 (a) Stress comes in a variety of forms from a variety of causes, and exhibits a variety of symptoms.

(i) Define stress.

(2 marks)

(ii) Discuss at least 2 environmental stressors which may affect on worker's current performances.

(8 marks)

(b) Zulkifli work as a machine operator which requires physical work. He works on 8-hour shift basis. Energy-expenditure rate of his physical work is 6.5 kcal/min. NIOSH-recommended 8-hour work capacity limits are 5 kcal/min for healthy males.

(i) Calculate rest period as a fraction of total work time.

(4 marks)

(ii) Calculate total rest period on 8-hour shift.

(2 marks)

(c) The result of extensive research on work physiology have shown that energy expenditure rate of a work is linearly related to the amount of oxygen consumed by the body and to heart rate. Heart rate, the number of heart beats per minute, is commonly used physiological measure of physical workload. Assess the relationship between heart rate and physical workload.

(4 marks)

Q6 Perform a biomechanical analysis of the task shown in the Figure Q6.

(a) Calculate the resultant moment (Nm) acting at the L5/S1 vertebral joint due to the static and dynamic forces.

Given;
The force exerted at the hand by load mg_L = 150 N.
Upper torso mass (including head and arms): mg_{BW} = 30 kg.
Acceleration of the load in the vertical (upwards) direction: 5 ms^{-2}.

Assume that the lift is being generated by lower limbs, and at this position, the upper body has only a vertical acceleration (5 ms^{-2}) with no angular rotation.

Horizontal distance "b" between torso centre of mass and L5-S1 joint = 250mm
Horizontal distance "h" between box centre of mass and L5-S1 joint = 400 mm

Where; Acceleration of load, $a_L = 5\ ms^{-2}$
Acceleration of torso, $a_B = 5\ ms^{-2}$

And dynamic forces; On load, $F_{aL} = -m_L a_L$ (in y direction)
On torso, $F_{aB} = -m_B a_B$ (in y direction)

(10 marks)

(b) Calculate the muscle force required obtaining equilibrium at the joint and the resultant joint compression force (acting in the long axis of the vertebrae) and shear force.

Assume a muscle moment arm "E" of 70 mm for the extensor muscle, and that the line of action of the muscle force (F_{muscle}) is parallel to the long axis of the vertebrae.

Force due to abdominal pressure $F_A = 200$ N
Moment arm of force $F_A = 120$ mm
Angle between the transverse plane of the L5/S1 joint and the horizontal: $\alpha = 50^0$

(10 marks)

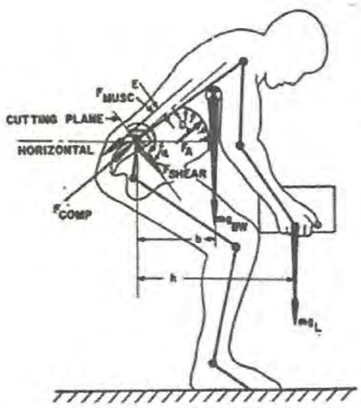

Figure Q6: Cantilever low-back model of lifting

END OF QUESTIONS

Appendix I

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER II /2020/2021 PROGRAM : BDD
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Tables
Data from *Kodak's Ergonomic Design for People at Work, 2nd Ed.* Table 1.5, pp 48 - 49.

Index	The table section in Yellow may be edited.	Men Mean	Men -sd	Men +sd	Women Mean	Women -sd	Women +sd	Conversions to US Trad cm, kg in, lb
1	None	0.0			0.0			0
2	Stature {9}	174.5	6.6	6.6	162.1	6.0	6.0	0.394
3	Weight {43}	83.2	15.1	15.1	66.4	13.9	13.9	2.2
4	Forward Functional Reach - Inc body depth {1a}	82.6	4.8	4.8	74.1	3.9	3.9	0.394
5	Frwd Func Reach - acromial process to pinch {1b}	63.8	4.3	4.3	62.5	3.4	3.4	0.394
6	Frwd Func Reach - abdomen to pinch {1c}	62.1	8.9	8.9	60.4	6.7	6.7	0.394
7	Abdominal Extension Depth {2}	23.1	2.0	2.0	20.9	2.1	2.1	0.394
8	Waist Height - Stand {3}	106.3	5.4	5.4	101.7	5.0	5.0	0.394
9	Tibial Height {4}	45.6	2.8	2.8	42.0	2.4	2.4	0.394
10	Knuckle Height - Stand {5}	75.5	4.1	4.1	71.0	4.0	4.0	0.394
11	Elbow Height - Stand {6}	110.5	4.5	4.5	102.6	4.8	4.8	0.394
12	Shoulder Height - Stand {7}	143.7	6.2	6.2	132.9	5.5	5.5	0.394
13	Eye Height - Stand {8}	164.4	6.1	6.1	151.4	5.6	5.6	0.394
14	Functional Overhead Reach - Stand {10}	209.6	8.5	8.5	199.2	8.6	8.6	0.394
15	Thigh Clearance Height - Sit {11}	14.7	1.4	1.4	12.4	1.2	1.2	0.394
16	Elbow Rest Height - Sit {12}	24.1	3.2	3.2	23.1	3.0	3.0	0.394
17	Midshoulder Height - Sit {13}	62.4	3.2	3.2	58.0	2.7	2.7	0.394
18	Eye Height - Sit {14}	78.7	3.6	3.6	73.7	3.1	3.1	0.394
19	Sitting Height - Normal {15}	86.6	3.8	3.8	81.8	4.0	4.0	0.394
20	Functional Overhead Reach - Sit {16}	128.4	8.5	8.5	119.8	6.6	6.6	0.394
21	Knee Height - Sit {17}	54.0	2.7	2.7	51.0	2.6	2.6	0.394
22	Popliteal Height - Sit {18}	44.6	2.5	2.5	41.0	1.9	1.9	0.394
23	Leg Length - Sit {19}	105.1	4.8	4.8	100.7	4.3	4.3	0.394
24	Upper-Leg Length - Sit {20}	59.4	2.8	2.8	57.4	2.6	2.6	0.394
25	Buttocks-to-Popliteal Length - Sit {21}	49.8	2.5	2.5	48.0	3.2	3.2	0.394
26	Elbow-to-Fist Length {22}	38.5	2.1	2.1	34.8	2.3	2.3	0.394
27	Upper-Arm Length {23}	36.9	1.9	1.9	34.1	2.5	2.5	0.394
28	Shoulder Breadth {24}	45.4	1.9	1.9	39.0	2.1	2.1	0.394
29	Hip Breadth {25}	35.6	2.3	2.3	38.0	2.6	2.6	0.394
30	Foot Length {26}	26.8	1.3	1.3	24.1	1.1	1.1	0.394
31	Foot Breadth {27}	10.0	0.6	0.6	8.9	0.5	0.5	0.394
32	Hand Thickness, Metacarpal III {28}	3.3	0.2	0.2	2.8	0.2	0.2	0.394
33	Hand Length {29}	19.0	1.0	1.0	18.4	1.0	1.0	0.394
34	Digit Two Length {30}	7.5	0.7	0.7	6.9	0.8	0.8	0.394
35	Hand Breadth {31}	8.7	0.5	0.5	7.7	0.5	0.5	0.394
36	Digit One Length {32}	12.7	1.1	1.1	11.0	1.0	1.0	0.394
37	Breadth of Digit One Interphalangeal Joint {33}	2.3	0.1	0.1	1.9	0.1	0.1	0.394
38	Breadth of Digit Three Interphalangeal Joint {34}	1.8	0.1	0.1	1.5	0.1	0.1	0.394
39	Grip Breath, Inside Diameter {35}	4.9	0.6	0.6	4.3	0.3	0.3	0.394
40	Hand Spread, D1 to D2, 1st Phal. Joint {36}	12.4	2.4	2.4	9.9	1.7	1.7	0.394
41	Hand Spread, D1 to D2, 2nd Phal. Joint {37}	10.5	1.7	1.7	8.1	1.7	1.7	0.394
42	Head Breadth {38}	15.3	0.6	0.6	14.5	0.6	0.6	0.394
43	Interpupillary Breadth {39}	6.1	0.4	0.4	5.8	0.4	0.4	0.394
44	Biocular Breadth {40}	9.2	0.5	0.5	9.0	0.5	0.5	0.394
45	Blank	1.0	1.0	1.0	1.0	1.0	1.0	1

Data Table in SI units

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Anthropometrics Table

Appendix II

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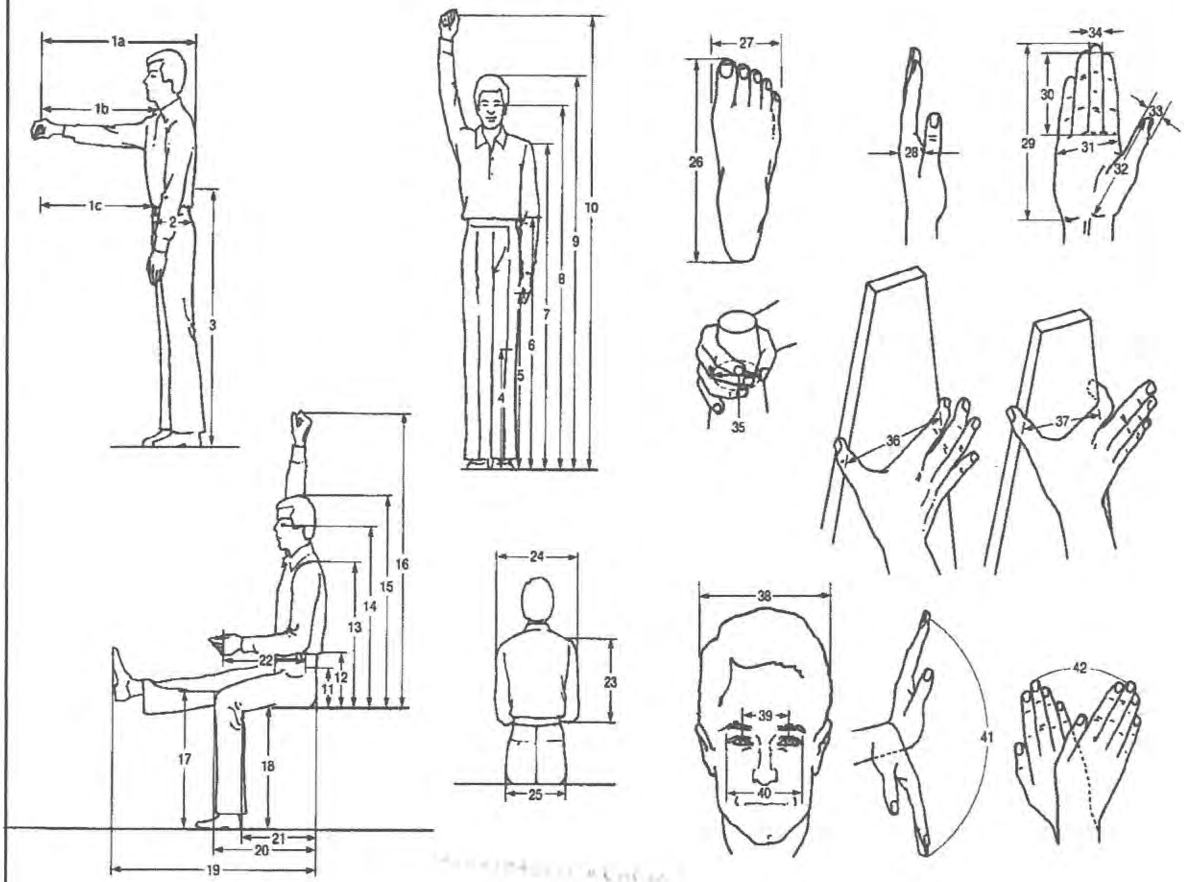
Location References and Data Source
Information from *Kodak's Ergonomic Design for People at Work, 2nd Ed*
S. N. Chengalur, S. H. Rodgers, T. E. Bernard (ed)
John Wiley and Sons, 2004
http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471418633.html

pp 52-53



Anthropometric Dimension References