



KOLEJ UNIVERSITI TEKNOLOGI
TUN HUSSEIN ONN

PEPERIKSAAN AKHIR
SEMESTER I
SESI 2006/07

NAMA MATAPELAJARAN : ERGONOMIK

KOD MATA PELAJARAN : BKM 4543

KURSUS : 4 BKJ

TARIKH PEPERIKSAAN : NOVEMBER 2006

JANGKA MASA : TIGA (3) JAM

ARAHAN : 1. JAWAB **SEMUA** SOALAN DI
BAHAGIAN A
2. JAWAB MANA-MANA **TIGA (3)**
SOALAN DI BAHAGIAN B.

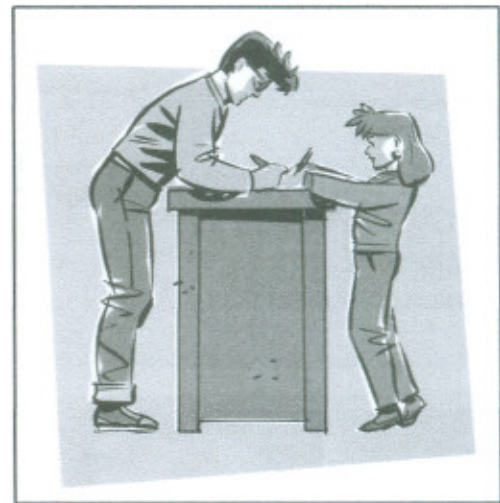
KERTAS SOALAN INI MENGANDUNGI TIGA BELAS (13) MUKA SURAT BERCETAK

BAHAGIAN A

- S1 (a) Apakah yang di maksudkan dengan antropometri statik? (2 markah)
- (b) Nyatakan kepentingan – kepentingan data antropometri kepada seorang jurutera rekabentuk. (5 markah)
- (c) Di dalam Rancangan Malaysia 9 (RMK9), Kementerian Pelajaran telah bercadang untuk membina lebih banyak sekolah rendah selaras dengan pertumbuhan populasi rakyat Malaysia. Sekolah – sekolah ini akan dilengkapi dengan makmal – makmal sains. Perabot asas di dalam makmal tersebut adalah meja kerja, tetapi banyak aduan mengenai projek – projek sebelum ini telah diperolehi daripada guru – guru, berkenaan ketinggian seperti yang ditunjukkan dalam Rajah S1(a) dan (b).
- (i) Komen masalah – masalah untuk kedua – dua rekabentuk sedia ada seperti yang ditunjukkan dalam Rajah S1(a) dan (b). (5 markah)
- (ii) Cadangkan rekabentuk yang sesuai untuk mengatasi masalah seperti yang dinyatakan di S1c(i). (8 markah)



Rajah S1(a)



Rajah S1(b)

S2

Zahid adalah seorang pekerja di bahagian pembungkusan di kilang Kimberly Clark, Kluang. Beliau terlibat di dalam tugas yang melibatkan mengangkat kotak pada ketinggian meja dan ke atas pada kadar $F = 6/\text{min}$. Lokasi mendarat kotak tersebut ialah 40 cm di hadapan pada kedudukan tengah kaki. Jarak angkatan menegak ialah 30 cm, dan ketinggian permulaan ialah 100 cm daripada paras lantai.

- (a) Kira beban maksimum yang dibenarkan (kg) yang sepatutnya diangkat, dengan menggunakan persamaan ubahsuai NIOSH (1991) bagi *Recommended Weight Limit (RWL)*:

$$RWL = 23 \left\{ \frac{25}{H} \right\} \left\{ 1 - (0.003 |V-75|) \right\} \left\{ 0.82 + \frac{4.5}{D} \right\} \left\{ \frac{FM}{CM} \right\} \left\{ 1 - (0.003A) \right\}$$

Anggap masa yang diperuntukkan untuk mengangkat tidak melebihi sejam/hari, kotak tersebut dipegang dengan pegangan yang baik dan angkatan adalah simetri.

(6 markah)

- (b) Kira beban angkatan maksimum (kg) yang sepatutnya diangkat, dengan menggunakan persamaan asal NIOSH *Action Limit*.

$$AL \text{ (kg)} = 40(15/H)[1-(0.004|V-75|)](0.7+7.5/D)(1-F/F_{\max})$$

Anggap $F_{\max} = 18$

(6 markah)

- (c) Cadangkan dan terangkan secara ringkas tiga (3) postur dan kedudukan yang baik (dengan lakaran) untuk Zahid ketika melakukan proses angkatan tersebut iaitu permulaan, semasa dan penamat.

(8 markah)

BAHAGIAN B

S3 (a) Tekanan (*stress*) datang dalam pelbagai bentuk dan penyebab, dan memperlihatkannya di dalam pelbagai simptom.

(i) Takrifkan tekanan (*stress*)

(2 markah)

(ii) Bincangkan sekurang – kurangnya dua (2) penyebab tekanan (*stress*) persekitaran yang mana akan memberi kesan kepada pencapaian semasa pekerja.

(8 markah)

(b) Kin Yuen bekerja sebagai operator mesin yang mengkehendakinya melakukan kerja – kerja fizikal. Beliau bekerja di dalam shif 8 jam. Kadar penggunaan tenaga untuk kerja – kerja fizikalnya adalah 6.5 kcal/min. Had cadangan NIOSH untuk kerja selama 8 jam adalah 5 kcal/min sahaja bagi lelaki yang sihat.

(i) Kira waktu rehat sebagai pecahan daripada keseluruhan waktu kerjanya.

$$\text{Diberi } R = \frac{(PWC - E_{job})}{(E_{rest} - E_{job})}$$

PWC = Kapasiti kerja fizikal

E_{job} = Kadar penggunaan tenaga yang diperlukan untuk melakukan kerja

E_{rest} = Kadar penggunaan tenaga semasa keadaan rehat (1.5 kcal/min untuk rehat sambil duduk)

(4 markah)

(ii) Kira jumlah waktu rehat untuk shif 8 jam.

(2 markah)

(c) Hasil kajian di dalam fisiologi kerja menunjukkan bahawa kadar penggunaan tenaga untuk sesuatu kerja adalah bergantung secara linear dengan amaun oksigen yang digunakan oleh badan dan kadar denyutan nadi. Kadar denyutan nadi; bilangan denyutan seminit, adalah ukuran fisiologikal yang selalu digunakan untuk mengukur beban kerja fizikal. Terangkan perhubungan di antara kadar denyutan nadi dan beban kerja fizikal.

(4 markah)

- S4 (a) Sistem muskuloskeletal mempunyai lebih kurang 400 otot, yang merangkumi 40 hingga 50 peratus daripada berat badan.
- (i) Apakah yang membina otot? (5 markah)
- (ii) Nyatakan fungsi – fungsi otot. (5 markah)
- (b) Berikut adalah populasi ekstrem yang mempengaruhi rekabentuk fasiliti dan peralatan:
- 5th persentil wanita
 - 95th persentil wanita
 - 5th persentil lelaki
 - 95th persentil lelaki
 - 50th persentil keseluruhan populasi
- Apakah populasi ekstrem yang paling mempengaruhi rekabentuk – rekabentuk yang di senaraikan pada (i) hingga (v). Terangkan dengan ringkas pilihan anda.
- (i) Pintu LRT (*light rapid transit*). (2 markah)
- (ii) Lorong di pesawat penerbangan komersil (sebagai contoh kapal terbang Boeing 747). (2 markah)
- (iii) Ketinggian kaunter pembayaran pasaraya. (2 markah)
- (iv) Ketinggian maksimum rak untuk almari wanita. (2 markah)
- (v) Ketinggian katil bayi. (2 markah)

- S5 (a) Zurina bekerja di sebuah syarikat percetakan di Sri Gading. Semasa bekerja pada hari Jumaat lepas, beliau didapati telah terdedah kepada kebisingan sebanyak 80 dBA selama dua jam, 90 dBA selama tiga jam dan 96 dBA selama dua jam. Tentukan apakah tahap *8 jam - TWA* (*Time Weighted Average*) bunyi yang telah dialaminya.

Diberi tahap pendedahan yang dibenarkan ialah 32 jam untuk 80 dBA dan 8 jam untuk 90 dBA.

$$Dos\ kebisingan,\ D = \left[100 \times \sum_{i=1}^n \frac{C_i}{T_i} \right]$$

$$TWA = [16.61 \times \log_{10}(D/100) + 90]$$

(10 markah)

- (b) Bincangkan bagaimana untuk mengawal kebisingan dari segi kejuruteraan.
(5 markah)
- (c) Bagaimana seseorang pekerja itu dapat lebih selesa apabila bekerja secara berdiri bagi suatu jangka masa yang lama?
(5 markah)

- S6 (a) Perekabentuk sistem telah mengklasifikasikan tiga (3) tahap peringatan iaitu amaran, peringatan dan nasihat. Bezakan di antara ketiga – tiga tahap tersebut dengan contoh dan lakaran yang sesuai.
(12 markah)

- (b) Apakah prinsip – prinsip yang perlu dipertimbangkan oleh perekabentuk apabila merekabentuk paparan pelbagai (*multidisplays*). Pilih sekurang – kurangnya tiga (3) prinsip.
(8 markah)

TERJEMAHAN**PART A**

- S1 (a) What is defined by static anthropometry? (2 marks)
- (b) State the importances of anthropometrics data for a design engineer. (5 marks)
- (c) In Rancangan Malaysia 9 (RMK9), Ministry of Education planned to build more primary schools inline with population growth of Malaysian. These schools will be equipped with science laboratories. Basic furnitures in the labs are workbenches but there were lot of complaints from the teachers about the height from the previous projects as shown in Figure S1(a) and (b).
- (i) Comments on problems occurred for both design as shown in Rajah S1(a) and (b) (5 marks)
- (ii) Suggest appropriate design to overcome the problems stated in S1a(i). (8 marks)



Figure S1(a)



Figure S1(b)

S2

Zahid is a worker in packaging department at Kimberly Clark plant, Kluang. He is involved in a task which involves occasional box lifting at bench height and above at a rate of $F = 6/\text{min}$. The horizontal location of the box is 40 cm in front of the mid foot position. The vertical distance lifted is 30 cm, and the starting height is 100 cm above the floor.

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

$$\text{RWL} = 23 \left\{ \frac{25}{H} \right\} \left\{ 1 - (0.003 |V-75|) \right\} \left\{ 0.82 + 4.5/D \right\} \left\{ \frac{FM}{CM} \right\} \left\{ 1 - (0.003A) \right\}$$

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

(6 marks)

- (b) Calculate the maximum allowable load (kg) which should be lifted, using the original NIOSH Action Limit equation:

$$\text{AL (kg)} = 40 (15/H) [1 - (0.004 |V - 75|)] (0.7 + 7.5/D) (1 - F/F_{\text{max}})$$

Assume $F_{\text{max}} = 18$

(6 marks)

- (c) Suggest and briefly explain three (3) good postures and positions (sketching) for Zahid to complete the lifting task; start, during and end of the process.

(8 marks)

PART B

S3 (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)

(iii) Kin Yuen 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.

Calculate rest period as a fraction of total work time.

$$\text{Given } R = \frac{(PWC - E_{job})}{(E_{rest} - E_{job})}$$

PWC = physical work capacity

E_{job} = energy-expenditure rate required to perform the job

E_{rest} = energy-expenditure rate at rest (1.5 kcal/min for seated rest)

(4 marks)

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

(2 marks)

(b) 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. Explain the relationship between heart rate and physical workload.

(4 marks)

- S4** (a) The musculoskeletal system has about 400 muscles, which make up about 40 to 50 percent of the body weight.
- (i) What are muscles' built from? (5 marks)
 - (ii) State the function of muscles. (5 marks)
- (b) The following population extremes can influence the design of facilities and equipments:
- 5th percentile woman
 - 95th percentile woman
 - 5th percentile man
 - 95th percentile man
 - 50th percentile member of the population

What is the number of the preceding population extreme that most influences the designs listed in (i) to (v). Briefly explain on your selection.

- (i) LRT (light rapid transit) door. (2 marks)
- (ii) Commercial airline jet (i.e. Boeing 747 aircraft) aisle. (2 marks)
- (iii) Height of the supermarket cashier counter. (2 marks)
- (iv) Maximum shelf height for women's lockers. (2 marks)
- (v) Height of baby cot. (2 marks)

- S5** (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. Determine the *8-hour TWA (time weighted average)* sound level which has been experienced by her.

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

$$\text{Noise dose, } D = \left[100 \times \sum_{i=1}^n \frac{C_i}{T_i} \right]$$

$$\text{TWA} = [16.61 \times \log_{10}(D/100) + 90]$$

(10 marks)

- (b) Discuss how to control noise on engineering method. (5 marks)
- (c) How might workers be made more comfortable when having to stand for long period of time? (5 marks)

- S6** (a) System designers have classified three levels of alerts – warnings, cautions and advisories. Differentiate between all levels with appropriate examples and sketches. (12 marks)

- (b) What are the principles that designers may consider when designing multiple displays. Choose at least 3 principles. (8 marks)

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TABLE 10.2 Anthropometric Data (unit: inches)

| Measurement | Males | | Females | | Population Percentiles, 50/50 Males/Females | | |
|-------------------------------------|--------------------|------------|--------------------|-------------|--|--------|--------|
| | 50th percentile | $\pm 1S.D$ | 50th percentile | $\pm 1S.D.$ | 5th | 50th | 95th |
| Standing | | | | | | | |
| 1. Forward Functional Reach | | | | | | | |
| a. includes body depth | 32.5 | 1.9 | 29.2 | 1.5 | 27.2 | 30.7 | 35.0 |
| at shoulder | (31.2) | (2.2) | (28.1) | (1.7) | (25.7) | (29.5) | (34.1) |
| b. acromial process to | 26.9 | 1.7 | 24.6 | 1.3 | 22.6 | 25.6 | 29.3 |
| function pinch | | | | | | | |
| c. abdominal extension | (24.4) | (3.5) | (23.8) | (2.6) | (19.1) | (24.1) | (29.3) |
| to functional pinch | | | | | | | |
| 2. Abdominal Extension Depth | 9.2 | 0.8 | 8.2 | 0.8 | 7.1 | 8.7 | 10.2 |
| 3. Waist Height | 41.9 | 2.1 | 40.0 | 2.9 | 37.4 | 40.9 | 44.7 |
| | (41.3) | (2.1) | (38.8) | (2.2) | (35.8) | (39.9) | (44.5) |
| 4. Tibial Height | 17.9 | 1.1 | 16.5 | 0.9 | 15.3 | 17.2 | 19.4 |
| 5. Knuckle Height | 29.7 | 1.6 | 2.80 | 1.6 | 25.9 | 28.8 | 31.9 |
| 6. Elbow Height | 43.5 | 1.8 | 40.4 | 1.4 | 38.0 | 42.0 | 45.8 |
| | (45.1) | (2.5) | (42.2) | (2.7) | (38.5) | (43.6) | (48.6) |
| 7. Shoulder Height | 56.6 | 2.4 | 51.9 | 2.7 | 48.4 | 54.4 | 59.7 |
| | (57.6) | (3.1) | (56.3) | (2.6) | (49.8) | (55.3) | (61.6) |
| 8. Eye Height | 64.7 | 2.4 | 59.6 | 2.2 | 56.8 | 62.1 | 67.8 |
| 9. Stature | 68.7 | 2.6 | 63.8 | 2.4 | 60.8 | 66.2 | 72.0 |
| | (69.9) | (2.6) | (64.8) | (2.8) | (61.1) | (67.1) | (74.3) |
| 10. Functional Overhead Reach | 82.5 | 3.3 | 78.4 | 3.4 | 74.0 | 80.5 | 86.9 |
| Seated | | | | | | | |
| 11. Thigh Clearance Height | 5.8 | 0.6 | 4.9 | 0.5 | 4.3 | 5.3 | 6.5 |
| 12. Elbow Rest Height | 9.5 | 1.3 | 9.1 | 1.2 | 7.3 | 9.3 | 11.4 |
| 13. Midshoulder Height | 24.5 | 1.2 | 22.8 | 1.0 | 21.4 | 23.6 | 26.1 |
| 14. Eye Height | 31.0 | 1.4 | 29.0 | 1.2 | 27.4 | 29.9 | 32.8 |
| 15. Sitting Height, Normal | 34.1 | 1.5 | 32.2 | 1.6 | 32.0 | 34.6 | 37.4 |
| 16. Functional Overhead Reach | 50.6 | 3.3 | 47.2 | 2.6 | 43.6 | 48.7 | 54.8 |
| 17. Knee Height | 21.3 | 1.1 | 20.1 | 1.9 | 18.7 | 20.7 | 22.7 |
| 18. Popliteal Height | 17.2 | 1.0 | 16.2 | 0.7 | 15.1 | 16.6 | 18.4 |
| 19. Leg Length | 41.4 | 1.9 | 39.6 | 1.7 | 37.3 | 40.5 | 43.9 |
| 20. Upper-Leg Length | 23.4 | 1.1 | 22.6 | 1.0 | 21.1 | 23.0 | 24.9 |
| 21. Buttocks-to-Popliteal Length | 19.2 | 1.0 | 18.9 | 1.2 | 17.2 | 19.1 | 20.9 |
| 22. Elbow-to-Fit Length | 14.2 | 0.9 | 12.7 | 1.1 | 12.6 | 14.5 | 16.2 |
| | (14.6) | (1.2) | (13.0) | (1.2) | (11.4) | (13.8) | (16.2) |
| 23. Upper-Arm Length | 14.5 | 0.7 | 13.4 | 0.4 | 12.9 | 13.8 | 15.5 |
| | (14.6) | (1.0) | (13.3) | (0.8) | (12.1) | (13.8) | (16.0) |
| 24. Shoulder Breadth | 17.9 | 0.8 | 15.4 | 0.8 | 14.3 | 16.7 | 18.8 |

(continued)

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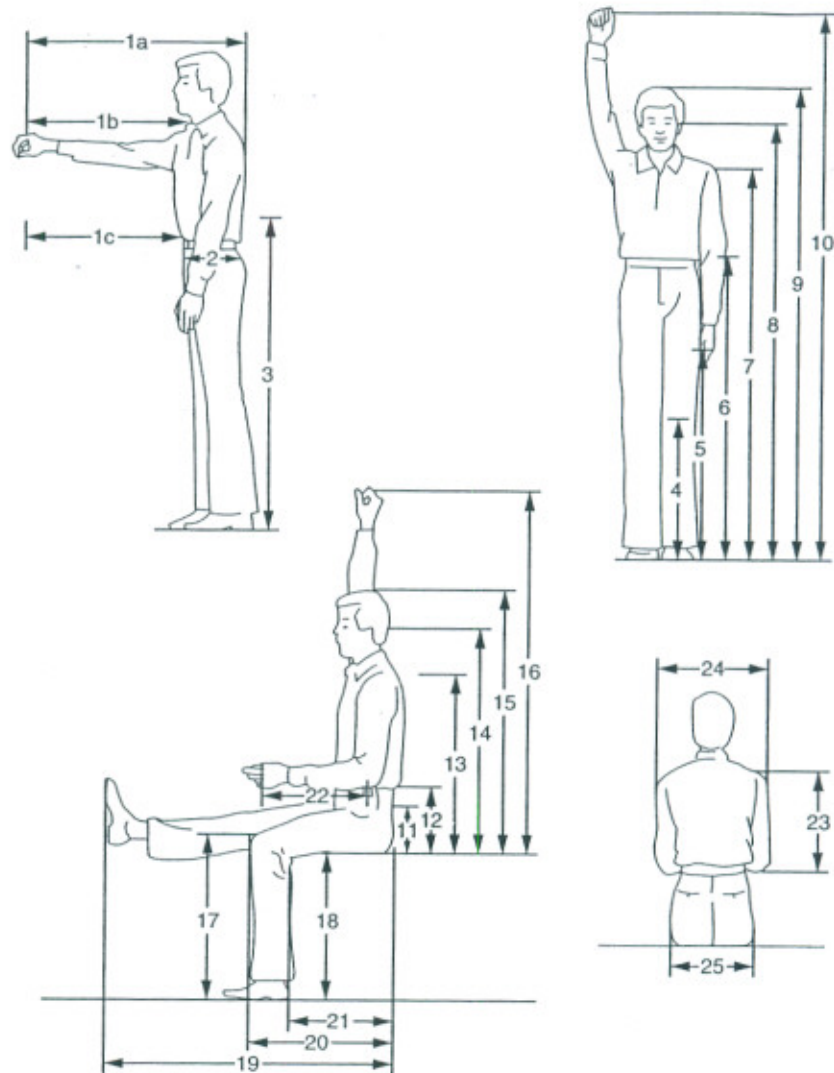


FIGURE 10.3

Anthropometric measures: standing and sitting. (Source: Eastman Kodak Company, 1986. *Ergonomic Design for People at Work*, Vol. 1. New York: Van Nostrand Reinhold.)