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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021**

COURSE NAME : THERMAL ENVIRONMENTAL DESIGN
COURSE CODE : BDE 40903
PROGRAMME CODE : BDD
EXAMINATION DATE : JULY 2021
DURATION : 3 HOURS
INSTRUCTION : ANSWER FIVE (5) QUESTIONS ONLY

TERBUKA

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

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- Q1**
- (a) Currently there are two well-known standards related to thermal comfort. Compare the main difference between BS EN ISO 7730 and ASHRAE 55 standards.

(8 marks)
 - (b) Give your opinion on the benefit of the development of open source ASHRAE comfort database MK I and MK II that had helped explosion of thermal comfort research activity around the world.

(8 marks)
 - (c) Describe how human body reacts to heat when wearing protective clothing and performing heavy work in hot and humid condition.

(4 marks)
- Q2**
- (a) There are two basic approaches we can take to evaluate thermal comfort; qualitative approach where we may not take any measurements but rely on other forms of evidence (i.e. interview, questionnaire). Quantitative approach where we carry out physical measurements. Give arguments on which is the best approach to use when people are complaining about feeling too hot or cold?

(8 marks)
 - (b) Assemble the body's heat energy balance through heat body loss and heat body production process.

(8 marks)
 - (c) Explain on the basic theory of adaptive thermal comfort.

(4 marks)

- Q3** (a) Natural ventilation, if used appropriately, has the potential to provide significant HVAC energy savings. Research has indicated that occupants of naturally ventilated offices have fewer sick building syndrome symptoms than occupants of air-conditioned offices. In your opinion, which type of ventilation that you think will benefit the occupants in offices in Malaysia? Appraise your opinion by elaborating it with proper examples.
- (8 marks)
- (b) A heat stress analysis has been made for an acclimatized road construction worker operating a roller for a four-hour period wearing long sleeves shirt and pants. The average outdoor dry bulb temperature for this period is 32.2 °C, the average natural wet-bulb temperature is 28.9 °C, and the average globe temperature is 32.8 °C for this period. Find and evaluate the:
- (i) Wet Bulb Globe Temperature (WBGT) value in °C;
 - (ii) the average metabolic rate if the worker takes a 15 minutes break by sitting in the shade every hour; and
 - (iii) the heat stress risk of the worker.
- (12 marks)
- Q4** (a) To achieve green building certification, there are three pathways to manage Indoor Air Quality, which are emission source control, ventilation and indoor air measurement. Examine the aim of each method with stating suitable examples.
- (10 marks)
- (b) Evaluate the pro and cons obtained when a top management of a company wants to improve the ventilation systems in the workplace.
- (10 marks)
- Q5** (a) You had been hired as the heat stress assessor for the commercial kitchen in a hotel. Most of the workers of the kitchen were foreign workers and worked in the kitchen daily from 5.00 am until 9.00 pm. The hotel management received an employee complaint regarding heat stress in the cooking section. The complaint alleged that employees were working in hot temperature cause by the radiant heat of the industrial stove and industrial oven during cooking and baking process. They felt dehydrated, the temperature may have affected an employee's breathing, an employee was sent to the emergency room for heat exhaustion, and the conditions were unworkable. As the heat stress assessor, propose heat stress investigation that will be carried out to the hotel management with appropriate elaboration.
- (12 marks)

- (b) The most used indicator of heat stress is air temperature. However, air temperature alone is not a valid or accurate indicator for heat stress. It should be always considered in relation to other factors such as environmental, personal, and work factors. Differentiate the following factors that relates with heat stress
- (i) Environmental factors;
 - (ii) personal factors; and
 - (iii) work factors

(8 marks)

- Q6** (a) As an indoor air quality assessor, you have conducted indoor air quality investigation and assessment inside a classroom in school building. The air velocity, temperature and humidity found from the measurement were 0.15 m/s, 26 °C, and 60 %, respectively. **Table Q6(a)** lists the results of chemical contaminant concentration of several compounds that have been measured.

Table Q6(a): Results of chemical contaminant inside a classroom

Type of Compound	Concentration
Carbon dioxide	10 ppm
Formaldehyde	0.2 ppm
Ozone	0.04 ppm
Respirable Particulate	0.11mg/m ³
TVOC	5.5 ppm

Evaluate the chemical contaminants in the classroom.

(10 marks)

- (b) Propose general solutions on improving the indoor air quality in the classroom mentioned in **Question 6(a)**.

(10 marks)

- END OF QUESTIONS -

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