Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	UTILISATION OF ELECTRICAL ENERGY
COURSE CODE	:	BEV 30803
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE TEST CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) According to the IEEE Standard 100 (1984), Harmonic in the power system is defined as "A sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency".

(i) Explain the difference between subharmonics and integer harmonics in a power system.

(4 marks)

(ii) List down and briefly discuss the two harmonic measurement indices.

(4 marks)

(b) An 880 VA, 220 V, 50 Hz load has a power factor of 0.8 lagging. Identify the value of parallel capacitance that is required to correct the load power factor to unity.

(5 marks)

(c) A generating station supplies power to the following load, as shown in **Table Q1(c).**

Table Q1(c): List of the connected load.

Load	Description
1	lighting load of 10 kW
2	Induction motor of 50 HP (37·3 kW) with 0·8 p.f. lagging and efficiency 0·85.
3	Synchronous motor of 25 HP (18·65 kW) with 0·9 p.f. lagging and efficiency 0·9.

(i) Calculate each power (a)-(j) delivered by the station as listed in **Table Q1(c)(i).**

(13 marks)

Table Q1(c) (i): Power of each connected load.

Load	Real Power (kW)	Apparent Power (kVA)	Reactive Power (kVAR)
1		(a)	
2	(b)	(c)	(d)
3	(e)	(f)	(g)
Total	**(h)**	**(i)**	**(j)**

(ii) Determine the overall system power factor.

(2 marks)

(iii) Calculate the value of the capacitance required to connect in parallel, which will raise the power factor to unity when a 120 Vrms, 50 Hz source is applied to the system.

(2 marks)

Q2 (a) An Earthing protects people and equipment from potentially dangerous over voltages and leakages associated with electrical equipment in homes, offices, retail outlets and industrial plants.

(i) Explain the **three (3)** different grounding versus bonding with an appropriate installation diagram and label.

(8 marks)

(ii) Sketch a logical condition of three phase lines that are using the "*TN-C system* type earthing arrangement with an appropriate explanation.

(6 marks)

(b) A single-phase motor circuit is protected by a circuit breaker with the maximum current at fault of 95.5 A in damaged condition. A fault occurs and causes a current flow through the earth's continuity path with the amount of heat power produced at the metal box is 5 kW. Due to the poor contact of the lock nut and bush connecting a steel conduit to a metal box, the resistance of this conduit connection alone is 0.4 Ω. Regulation D22 regarding the basic earthing requirements is given in **APPENDIX A**

(i) Analyse the current value of a protective device in a damaged condition.

(3 marks)

(ii) Analyse the fault current flows based on the amount of heat produced at the metal box.

(2 marks)

(iii) Evaluate the degree of risk of a fire developing.

(1 mark)

(c) A voltage surge disturbs equipment and causes electromagnetic radiation.

(i) Explain **two (2)** characteristics of atmospheric voltage surge.

(4 marks)

(ii) Explain **two (2)** the characteristics of lightning conductors as a primary protection against voltage surge with an appropriate installation diagram.

(6 marks)

Q3 (a) An industrial plant has an incandescent lighting load comprising 100 Nos. of 60W and 140 Nos. of 100 W. Each of the incandescent loads is planned to be replaced by 1 x 40 W fluorescent load.

Given data:

Lighting is required for 4000 hours/year

Cost of electricity is RM 0.22/kWh

Replacement cost is RM 13.5/unit

Each of the fluorescent ballast consumption as 15 W

100 W incandescent lamp	=	2200 lumens
60 W incandescent lamp	=	1320 lumens
40 W Fluorescent lamp	=	2400 lumens

Considering the facts listed above, determine:

(i) Annual energy savings

(10 marks)

(ii) Annual cost savings

(2 marks)

(iii) Replacement cost

(2 marks)

(iv) Payback period

(3 marks)

(b) A lecture hall with dimensions of 12 m long and 10 m wide is to be illuminated and the illuminance required is 350 Lux. Assuming a depreciation factor of 1.2 and utilisation factor of 0.6 for the lighting scheme design. If 36 W fluorescent lamps (75 lumens/watt) were to be used, calculate the number of fluorescent lamps required.

(13 marks)

- END OF QUESTIONS -

APPENDIX A

Regulation D22 (Basic Earthing Requirements)
States that earth leakage protection may be provided by means of fuses or excess current circuit breakers if the earth fault current available to operate the protective device and so make the faulty circuit dead exceeds: 1. 3 times the current rating of any semi enclosed fuse or any cartridge fuse having a fusing factor exceeding 1.5, used to protect the circuit, or 2. 2.4 times the rating of any cartridge fuse having a fusing factor not exceeding 1.5, used to protect the circuit, or 3. 1.5 times the tripping current of any excess current circuit breaker used to protect the circuit.