Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	POWER QUALITY
COURSE CODE	:	BNE 32603
PROGRAMME CODE	:	BNE
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) State the power quality definition from the perspective of utility company and the end user.

(4 marks)

(b) Briefly discussed the **FOUR (4)** major concerns toward power quality nowadays.

(4 marks)

(c) A small scale industrial plant in Malaysia is supplied through a 3-phase power supply. It has a total system impedance of 0.003 + j0.006 Ω. If the power system supplies a 500 KVA load that produces frequency spectrums of 250 Hz, 350 Hz, and 550 Hz at current rating 65 A, 40 A and 25 A respectively.

(i) Estimate the percentage of the bus voltage without the power factor correction connected to the line.

(8 marks)

(ii) Calculate the RMS current and TDD of the 500 KVA load.

(4 marks)

Q2 (a) **Figure Q2(a)** shows the voltage signal obtained from the distribution area. As the power quality expert:

(i) predict the type of power quality problems given by the voltage signal in the figure,

(2 marks)

(ii) describe the characteristic and **TWO (2)** causes of each power quality problem predicted in **Q2(a)(i)**,

(6 marks)

(iii) suggest **TWO (2)** mitigation techniques for each power quality problem predicted in **Q2(a)(i)**.

(4 marks)

(b) Describe the effect of voltage unbalanced on three-phase induction motor.

(2 marks)

(c) Given the symmetrical component of phase *abc* voltage as below:

$$V_{a0} = 1.4 \angle 0.5^0 \text{ V}, V_{b1} = 2.5 \angle 210^0 \text{ V}, V_{c2} = 1.8 \angle 280^0 \text{ V}.$$

(i) Estimate the percentage of voltage unbalanced factor.

(3 marks)

(ii) Determine the original unbalances phasor of the three phase voltage, V_a, V_b and V_c.

(3 marks)

Q3 (a) Power quality industry recognizes that power quality standards are critical to the viability/possibility of the industry.

(i) Suggest **ONE (1)** suitable standard codes and names, each, for voltage sag, surge, fluctuation and harmonic.

(2 marks)

(ii) Differentiate the American power quality standard and the International power quality standard.

(2 marks)

(b) A switchgear busbar is subjected to voltage variations of +19% and -21% from its nominal value lasting for up to 0.40 cycles due to the operation of an automatic welding machine.

(i) Argue, whether a device that is compliant with the CBEMA curve shown in **Figure Q3(b)** tolerate these voltage deviations.

(2 Marks)

(ii) By referring to the CBEMA curve as shown in **Figure Q3(b)**, predict the impact of the voltage variations if the duration lasts for 10 cycles.

(2 Marks)

(c) **Figure Q3(c)** shows the single line diagram of a small industrial plant where a variable speed drive rated 100 *HP*, 415 *V*, 50 *Hz* is supplied by a transformer rated at 500 *kVA*. The line current drawn by the load is given by the expression:

$i(t) = 100cos(\omega t - 30.37^{o}) + 20cos(5\omega t + 28.08^{o}) + 14cos(7\omega t - 32.66^{o}) + 8cos(11\omega t + 25.78^{o}) + 6cos(13\omega t - 34.78^{o})$.

Predict the percentage of load voltage harmonic at the point of common coupling if 5.65 % impedance is applied to the diagram.

(12 marks)

Q4 (a) A filter is a frequency-selective circuit. It is used to eliminate the harmonic components in voltage and current signal.

(i) Explain why active harmonics filter are more preferable instead of passive filter.

(4 Marks)

(ii) Suggest and sketch the circuit diagram of a filter that able to eliminate higher-order harmonics generated by nonlinear loads that are connected to the PCC. Also, shows the frequency response of the suggested filter.

(4 marks)

(b) Design a simple 7^{th} harmonic notch filter for a 415 V, three-phase, 50 Hz system where harmonics are produced due to a 5 converted supplied load. The power factor correction approach indicates a need for a 40 kVAR shunt capacitors.

(7 marks)

(c) With appropriate diagram, briefly explain the how the source of harmonics being located in the utility distribution feeder.

(5 marks)

Q5 (a) Construct a neat flow chart to show a case study follow up from a consumer complaint until an economical solution established by a PQ technologist.

(6 marks)

(b) List **FIVE (5)** problems with conductors and connectors, as well as the possible causes of the problems to occur.

(5 marks)

(c) Many power quality variations that occur within customer facilities are related to wiring and grounding problems.

(i) Describe how a proper grounding is important in power system.

(2 marks)

(ii) Suggest **THREE (3)** grounding solution for sensitive equipment.

(3 marks)

(d) Compare the function of general-purpose spectrum analyzer and special-purpose power system harmonic analyzers in monitoring and analysing harmonics problems in power system.

(4 marks)

- **END OF QUESTIONS** -

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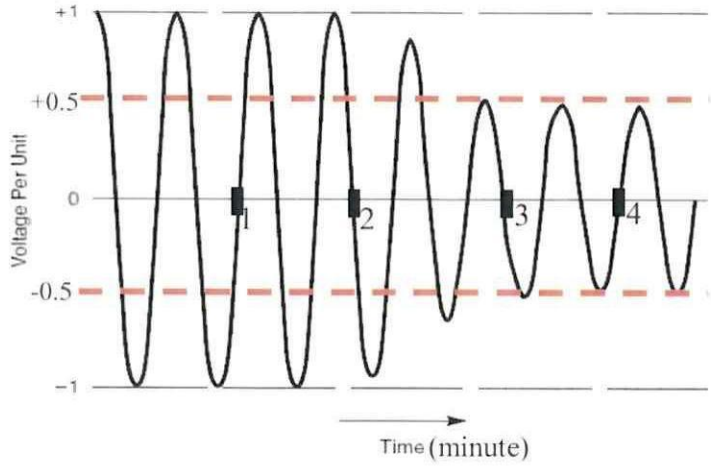
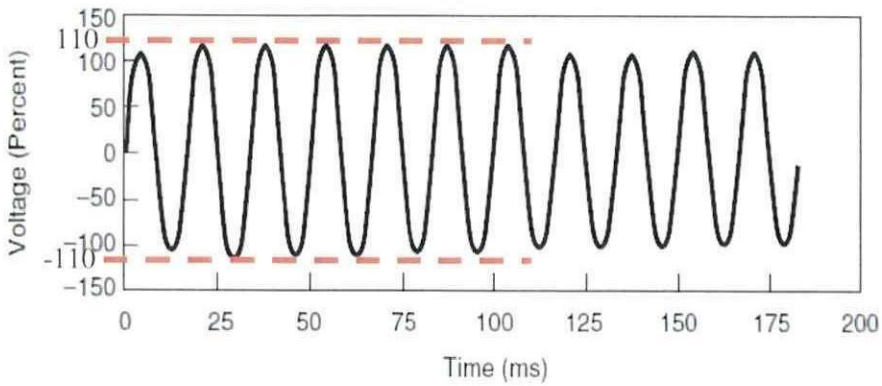


(i)



(ii)

Figure Q2(a)

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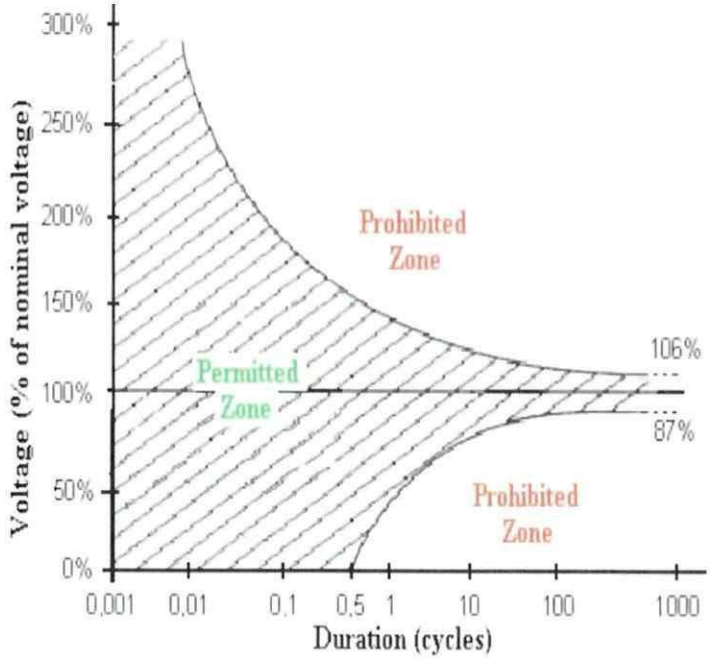

Figure Q3(b)

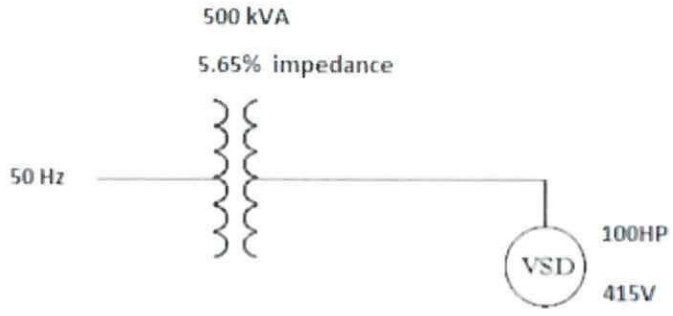

Figure Q3(c)