



**UTHM**  
Universiti Tun Hussein Onn Malaysia

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
(TAKE HOME)  
SEMESTER II  
SESSION 2019/2020**

COURSE NAME : POWER QUALITY  
COURSE CODE : BEF 44803  
PROGRAMME CODE : BEV  
EXAMINATION DATE : JULY 2020  
DURATION : 3 HOURS  
INSTRUCTION : ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

- Q1** (a) Restate in your own words the applicability of the ITIC/CBEMA curve as shown in **Figure Q1(a)** that can be easily understood especially by non-technical audience.

(2 Marks)

- (b) A 240 V single phase four-pole induction motor is used to control a small water pump. By referring to the ITIC/CBEMA curve in **Figure Q1(a)**, calculate the minimum voltage values for the motor at time of 3 milliseconds, 20 milliseconds, 500 milliseconds and 10 seconds.

(8 Marks)

- (c) A sinusoidal voltage of instantaneous value is applied to a nonlinear load impedance. The resulting instantaneous current is given by:

Determine the following quantities:

- (i) Active Power 'P' (1 Mark)

- (ii) Reactive Power 'Q' (1 Mark)

- (iii) Distortion Apparent Power 'D' (4 Marks)

- (iv) Displacement factor 'DPF' (1 Mark)

- (v) Distortion factor 'DF' (2 Marks)

- (vi) Power factor 'PF' (1 Mark)

- Q2** (a) An imbalanced three-phase system can cause three-phase motors and other three-phase loads to experience poor performance or premature failure. Calculate the percentage of current imbalance using the maximum deviation method, if current measurements carried out between the different phases of a three-phase supply are given as follows:

$$R-Y = 57.9 \text{ A}$$

$$Y-B = 57.2 \text{ A}$$

$$B-R = 55.0 \text{ A}$$

(10 Marks)

- (b) **Figure Q2(b)** shows the single line diagram of a small industrial plant where the variable speed drive is rated at 100 HP, 415 V, 50 Hz. The variable speed drive is supplied by a transformer rated at 500 kVA and 5.75% impedance. The line current drawn by the load is given by the following expression:

Analyse the percentage of load voltage harmonic at the point of common coupling.

(10 Marks)

- Q3** (a) A one-line diagram of an industrial plant is given in **Figure Q3(a)**. It is supplied from the utility 11 kV, three-phase, multi-grounded neutral distribution feeder. The short circuit data from the utility indicates a three-phase short circuit MVA of 100 MVA and an X/R ratio of 3.0. The transformer supplying the plant is rated at 1000 kVA, 11 kV – 415Y V, R = 1.5 %, X = 5.5 %. The system frequency is 50 Hz. Analyse the parallel resonant frequencies for the following values of the power factor correction capacitors applied to the 415 V bus:

(i) 150 kVAr.

(11 marks)

(ii) 300 kVAr.

(3 marks)

(iii) 450 kVAr.

(3 Marks)

- (b) A serious concern arising from the use of capacitors in an electrical power system is the possibility of system resonance. Specify some factors that contribute to series and parallel resonances in such systems.

(3 Marks)

- Q4** (a) Design a simple 5<sup>th</sup> 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 40 kVAR shunt capacitors.

(10 Marks)

- (b) There are two type of power filter that can be used to mitigate harmonics which

are active power filter (APF) and passive power filter (PPF). Distinguish the functions of APF from PPF and how they overcome the drawbacks of PPF in controlling harmonics.

(5 Marks)

- (c) Lightning strike is one of the main causes of transient in power system. An article on an international insurance company website states that the average claim for lightning-related damage is well over \$10,000. Outline the effects of transient on a power system.

(5 Marks)

- Q5** (a) A UPS is driving a 700 W load which has a lagging power factor of 0.8. The efficiency of the inverter is 85 %. The battery voltage is 48 V<sub>dc</sub>. Assume that there is a separate charger for the battery. Determine the following:

(i) kVA rating of the inverter.

(2 marks)

(ii) Wattage of the rectifier.

(2 marks)

(iii) AH rating of the battery for a backup time of 30 minutes.

(4 marks)

- (b) A three-phase supply with AC mains voltage of 400 V at 50 Hz has a voltage sag of -25 % due to a rural feeder and a nearby factory. A hospital needs a three-phase 415 V, 100 kVA, 0.8 lagging power factor. If a right-shunt UPQC is used as a unified power quality compensator as shown in **Figure Q5(b)**, calculate the rating of the shunt and series components of the UPQC to provide rated voltage across the load and to realize unity power factor at the AC mains. Assume both VSCs have the same ratings.

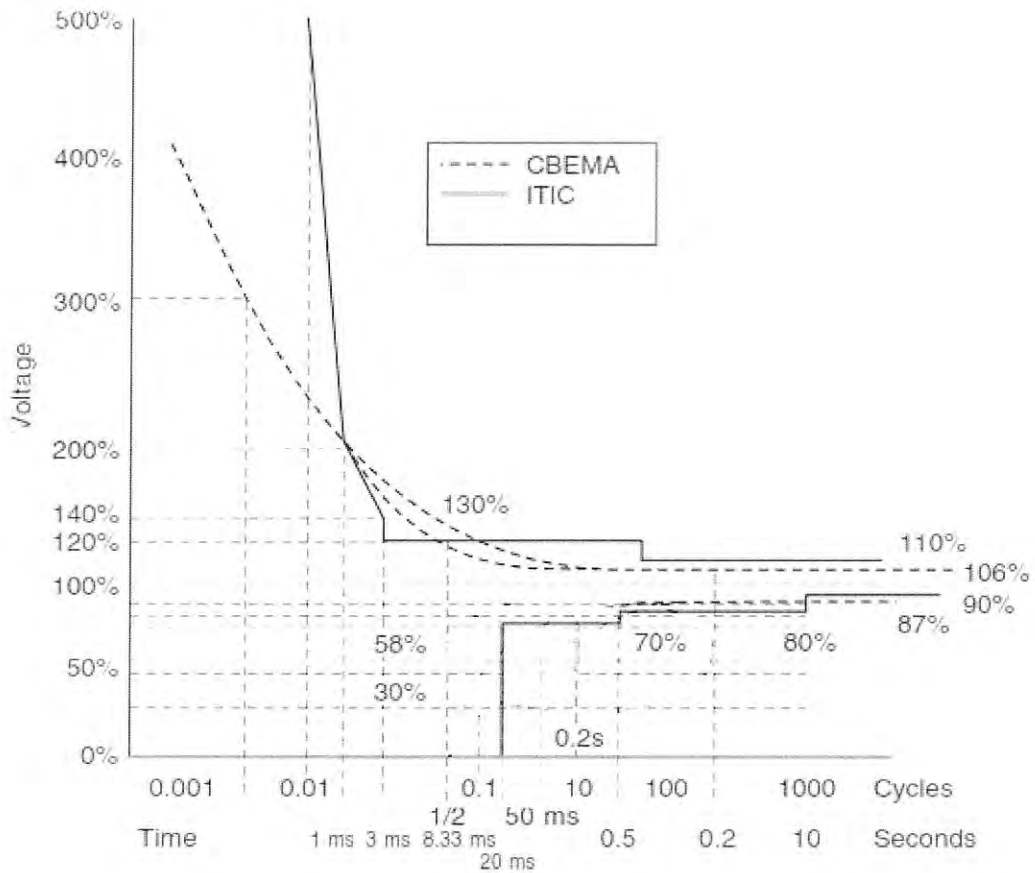
(12 Marks)

-END OF QUESTIONS -

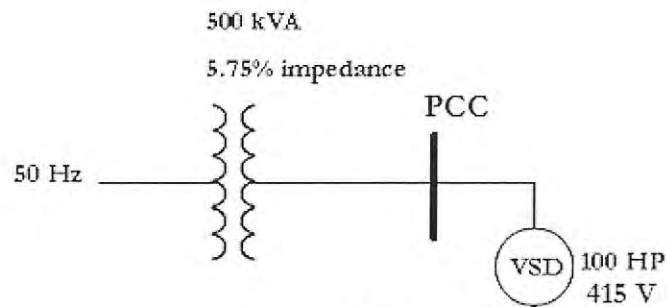
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**Figure Q1(a)**



**Figure Q2(b)**

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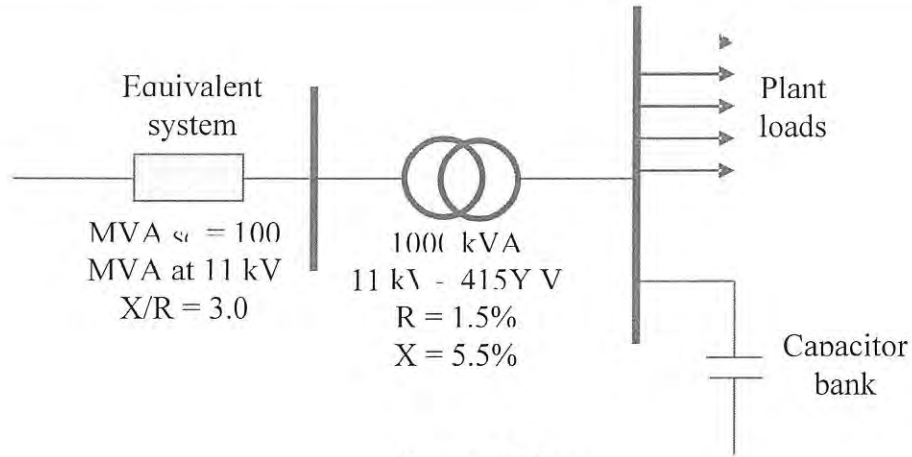


Figure Q3(a)

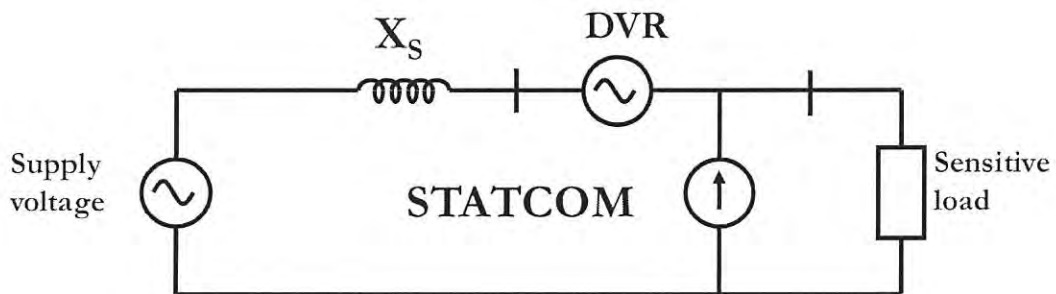


Figure Q5(b)