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**COURSE: ELECTRICAL ELECTRONICS ENGINEERING**

**EEE 326**

 **SECTION A**

**Question 1**

**Develop the theoretical framework required for the correction of the power factor for a multi - sectioned industrial complex from to where ; ; ; and to determine the kVAR rating of the capacitor and the magnitude of the capacitor (C) in farads required to correct the power factor of the complex. USE APPROPRIATE PHASOR DIAGRAMS.**

Where:

 Θ1> θ2

 P1=P2

 Q1>Q2

 S1>S2

 kVAR supplied by p.f correction equipment= Qcap= Q1 -Q2

Qcap= kVAR1- kVAR2

Qcap= P2(tan Θ1-tan θ2)

Recall Q= V2/XC

Therefore XC=V2/ Qcap

Also for capacitors; XC= 1/2πfC

Therefore C= 1/2πfXC

**Question 2**

**What determines the power factor of the Dangote Cement Factory at Abajana, Kogi State?**

The power factor of the dangote cement factory at abajana, kogi state is determined by its apparent power {KVA} and real power {KW}. Where the apparent power = real power + reactive power. The reactive power is the useless power or whereas the power that sustains the electromagnetic field and the real power is the power actually being used

**Question 3**

**The power factor (pf) of Eleme Petrochemical Industry Port Harcourt is given as ; what is the state of the pf of the complex when ; and . Draw the respective Phasor diagrams**.

When α>β, the state of the P.F is lagging or Inductive

When α<β. The state of the P.F is leading or Capacitive

When α=β. The power factor is unity. It is neither leading nor lagging.



**Question 4**

**For ; Write an expression for P and Q respectively with units in W and VAR. What does P and Q represent.**



From the power triangle, using Pythagoras theorem;

P= IV\*cosθ

Q= IV\*sinθ

**Question 5**

**Justify the need for power factor correction to ABUAD and PHCN or an IPP**.

. saving electricity bill, as ABUAD is charged for reactive power when the power factor drops below a certain level

. There will be improved voltage and reduced voltage drops.

. Electric cables will carry less load.

. Sustainable development is achieved as the carbon footprint is minimized.

. increase available power

. reduce installation size and maintains electric cables

**Question 6**

**Why is Q needed in an industrial complex with numerous induction motors?**

The reactive power drawn by the motor is needed because it is the energy needed to maintain the motor's internal magnetic field. It also damages such as overheating. Without the reactive power the system will fail.

 **SECTION B**

**8} An industrial load absorbs 5 MVA at a pf of 40% capacitive at 6kV. To improve the pf up to 85% capacitive, determine Q and C of the required capacitor. State how the correcting equipment will be integrated into the industrial power network for this load.**

Sold= 5MVA

P.Fold= 0.4 leading

P.Fold= P/S Therefore; P= 0.4\*(5\*10^6)= 2MW

Qold= √(5\*10^6)2-(2\*10^6)2= 4.58MVAR

P.Fnew=0.85

Snew= (2\*10^6)/0.85= 2.35MVA

Qnew=√(2.35\*10^6)2-(2\*10^6)2=1.23MVAR

Qcap= QOLD-QNEW=4.58-1.23=3.35MVAR

XC=V2/Q

XC=(6\*10^3)2/3.35\*10^6

XC= 10.75H

C=1/2ΠfXc= 1/(2\*3.142\*50\*10.75)= 29.6mF

This type of PF correction is Static.

**8b)**

 From the question, it is stated that the industrial power network is operating on an inductive load, it can be concluded that it will have a lagging (inductive) power factor; which means that the correcting equipment (capacitor of the appropriate size (29.6mF) which will be integrated in parallel to the industrial power network

**Question 9**

**The National Universities Commission (NUC) Complex in Abuja has a total load of 100kW. It is powered by a 415 V, three phase, 4 wire power supply. The power factor is 0.85lagging and NUC desires to avoid the payment of penalties for this poor power factor. What Should the facility manager advise NUC management to do? If an improved pf of 0.95 lagging is desired, determine the magnitude of the required Q and C.**

P= 100KW, V=415V, P.FOLD= 0.85 lagging

SOLD=P/ P.FOLD= (100\*10^3)/0.85=1.18\*10^5 VA

QOLD= √(1.18\*10^5)2-(100\*10^3)2 =62.6\*10^3VAR

AT 0.95 P.F

SNEW=1.05\*10^5VA

QNEW=√(1.05\*10^5)2-(100\*10^3)2=32.02KVAR

Qcap= QOLD-QNEW=62.6-32.02=30.58KVAR

XC=V2/Q

XC=(415)2/30.58\*10^3

XC= 5.63H

C=1/2ΠfXc= 1/(2\*3.142\*50\*5.63)= 56.5Mf

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The facility manager should advice the NUC management to improve the power factor of the system to at least 0.95 PF to prevent reactive power charges and save electric bills.

**Question 10**

**Undertake a comparative analysis as an Electrical Power Management Consultant and use techno – economic facts and data to advice a client (Globacom Nigeria Ltd) requiring a 20kW induction motor to power its intended fruit juice factory from motor choices given the following details:**

|  |  |  |
| --- | --- | --- |
| **Motor/parameters** |  |  |
| **kW** | **20** | **20** |
| **Phases** | **3** | **3** |
| **Line Voltage** | **415** | **415** |
| **pf** | **0.85** | **0.95** |
| **S** |  |  |
| **Q** |  |  |
| **PREVIOUS METER READING (kWhr)** | **23,000** |
| **NEW METER READING (kWhr)** | **25,000** |
| **kWhr charge** | **#55/kWhr** |
| **Demand(kW) Charge** | **#35/kW** |
| **Capacity (kVA) Charge** | **#70/kVA** |
| **Reactive Power (kVAR) Charge** | **#25/kVAR** |

**Justify clearly your choice of recommended motor.**

As an electrical power management consultant I would advise the client to buy Motor M2 because of the low reactive power {for my calculations below} compared to motor M1 and also due to the high power factor of (0.95).

Also when the rates for the reactive power are to be paid, the client pays less if he uses the motor M2. He saves on the electricity bill

 P= 20KW, P.FM1=0.85

SM1=P/P.F= (20\*10^3)/0.85= 23.5KVA

QM1=√(23.5\*10^3)2-(20\*10^3)2= 12.3Kvar

P.FM2=0.95

SM2= P/P.FM2= (20\*10^3)/0.95= 21.1KVA

QM2=√(21.1\*10^3)2-(20\*10^3)2 =0.67Kvar