Department of Mechanical, Materials and Manufacturing Engineering

The University of Nottingham

Electromechanical Devices MMME2051

Exercise Sheet 4 – Three phase and power factor

4.1 Why is power factor important? Consider the following situation. A load running off a 240V AC supply dissipates a power of 3 kW. What current would it draw if it were purely resistive and had a power factor of 1 (for example, a 3-bar electric fire)? What current would it draw if it were highly inductive and had a power factor of 0.7 (for example, a very large single phase induction motor)?

12.5 A; 17.9A

4.2 A balanced 3-phase 415V (line) 50Hz supply feeds three heating elements each with a resistance of 50 Ω connected in star. Calculate the line current and total power supplied.

4.792 A; 3.44 kW

4.3 A balanced 3-phase 415V (line) 50Hz supply feeds three coils each with an inductance of 20mH and resistance 4Ω connected in star. Calculate the line current magnitude and phase angle, power factor and total power supplied.

32.2A; –57.5°; 0.54 lagging; 12.43kW

4.4 A 240V (rms) 50 Hz single phase supply is connected to a load which draws a current of 12A with a power factor of 0.6 lagging. Express this current in Cartesian form. What value of current (expressed in Cartesian form) must be drawn through an additional, purely capacitive load, so that the power factor becomes 1? Calculate the magnitude of the overall current and the value of capacitor needed. By how much has the required current capacity of the power supply reduced? (This is called **power factor correction).**

7.2 –j9.6 A; j9.6 A; 7.2A; 127 μF; 40%

4.5 A balanced 3-phase 220V (line) 60Hz supply feeds a star connected load, of which phase comprises a 75Ω resistor in series with a 33μF capacitor. Calculate the impedance per phase in Cartesian and polar form, line current magnitude and phase angle, and total power supplied.

75–j80.4 Ω; 109.9Ω ∠–47°, 1.156A, ∠47° leading, 300.4W.

4.6 (Same as Q 4.4 but slightly harder). A 240V (rms) 50 Hz single phase supply is connected to a load which draws a current of 12A with a power factor of 0.6 lagging. Express this current in Cartesian form. What value of current (expressed in Cartesian form) must be drawn through an additional, purely capacitive load, so that the power factor becomes **0.9** lagging (a more realistic value than increasing it to 1)? Calculate the magnitude of the overall current and the value of capacitor needed. By how much has the required current capacity of the power supply reduced?

7.2 –j9.6 A; j6.11A; 8A; 81.1μF; 33.3%