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Question: 1

In a balanced three-phase system, the phase voltage is 277V and the total active power is 150 kW. If the power factor is 0.95 lagging, what is the line current?

- A. 184 A
- B. 209 A
- C. 319 A
- D. 361 A

Answer: C

Explanation: $V_L = \sqrt{3} * V_P = \sqrt{3} * 277 = 480 \text{ V}$

$$P = \sqrt{3} * V_L * I_L * \cos \phi$$

$$150,000 = \sqrt{3} * 480 * I_L * 0.95$$

$$I_L = 150,000 / (\sqrt{3} * 480 * 0.95) = 319 \text{ A}$$

Question: 2

What is the primary function of the surge suppressor circuit found in some variable frequency drives (VFDs)?

- A. To limit the flow of harmonic currents.
- B. To maintain power factor correction.
- C. To protect the VFD from high-voltage transients.
- D. To prevent the transmission of electromagnetic interference.

Answer: C

Explanation: The primary function of the surge suppressor circuit found in some variable frequency drives (VFDs) is to protect the VFD from high-voltage transients. These transients can be caused by switching events or other disturbances in the power system, and the surge suppressor helps to prevent

damage to the sensitive electronic components within the VFD.

Question: 3

In a balanced three-phase system, the phase voltage is 277V and the total reactive power is 75 kVAR. If the power factor is 0.8 lagging, what is the line current?

- A. 113 A
- B. 154 A
- C. 204 A
- D. 267 A

Answer: C

Explanation: $V_L = \sqrt{3} * V_P = \sqrt{3} * 277 = 480 \text{ V}$

Power factor = 0.8, so $\phi = \arccos(0.8) = 36.87^\circ$

$S = Q / \sin \phi = 75,000 / \sin(36.87^\circ) = 125 \text{ kVA}$

$I_L = S / (\sqrt{3} * V_L) = 125,000 / (\sqrt{3} * 480) = 204 \text{ A}$

Question: 4

Which of the following is the most effective method to mitigate the impact of a standard 6-pulse VFD on the life expectancy of the power factor correction capacitors in the facility?

- A. Installing a line reactor
- B. Upgrading to a 12-pulse VFD
- C. Oversizing the capacitor bank
- D. Implementing active harmonic filtering

Answer: B

Explanation: Upgrading from a 6-pulse to a 12-pulse VFD is the most effective method to mitigate the impact of a standard 6-pulse VFD on the life expectancy of the power factor correction capacitors in the facility. The 12-pulse configuration significantly reduces the harmonic content in the input current, which helps to minimize the additional stress and heating on the capacitors.

Question: 5

A three-phase, 460 V, 60 Hz, 10 hp induction motor has a full-load efficiency of 90% and a full-load power factor of 0.85. The full-load phase current of the motor is approximately:

- A. 8.9 A
- B. 10.5 A
- C. 12.1 A
- D. 13.7 A

Answer: B

Explanation: To calculate the full-load phase current, we can use the formula:

$$\text{Phase current (A)} = (\text{Full-load line current}) / \sqrt{3}$$

Where:

Full-load line current = 15.5 A (from Question 15)

Plugging in the value, we get:

$$\text{Phase current} = 15.5 / \sqrt{3} = 10.5 \text{ A}$$

Question: 6

A 3-phase, 480 V, 60 Hz, 100 HP induction motor has a full-load efficiency of 94% and a full-load power factor of 0.90 lagging. What is the approximate full-load current of the motor?

- A. 120 A
- B. 130 A

- C. 140 A
- D. 150 A

Answer: B

Explanation:

To calculate the full-load current of the motor, we can use the formula:

$$I = (\text{HP} \times 746) / (\sqrt{3} \times V \times \text{Eff} \times \text{PF})$$

Where:

HP = horsepower = 100 HP

V = line voltage = 480 V

Eff = full-load efficiency = 0.94

PF = full-load power factor = 0.90 lagging

Plugging in the values:

$$I = (100 \times 746) / (\sqrt{3} \times 480 \times 0.94 \times 0.90)$$

$$I = 129.61 \text{ A}$$

Rounding to the nearest 10 A, the answer is 130 A.

Question: 7

A 3-phase, 60 Hz, 480 V, 100 HP induction motor is operating at a power factor of 0.85 lagging and an efficiency of 92%. What is the line current drawn by the motor?

- A. 132 A
- B. 138 A
- C. 144 A
- D. 150 A

Answer: B

Explanation:

To find the line current drawn by the induction motor, we can use the formula:

$$I = (P_{in} / (\sqrt{3} \times V \times \cos(\theta) \times \eta)) \times 1000 / 746$$

Where:

I = Line current (in A)

P_{in} = Input power (in kW)

V = Line voltage (480 V)

θ = Power factor angle ($\cos^{-1}(0.85) = 31.79^\circ$)

η = Efficiency (0.92)

The input power can be calculated from the mechanical power and the efficiency:

$$P_{in} = P_{mech} / \eta$$

$$P_{in} = (100 \text{ HP} \times 746 \text{ W/HP}) / 0.92$$

$$P_{in} = 81.3 \text{ kW}$$

Substituting the values, we get:

$$I = (81.3 \text{ kW} / (\sqrt{3} \times 480 \text{ V} \times 0.85 \times 0.92)) \times 1000 / 746$$

$$I = 138 \text{ A}$$

Therefore, the line current drawn by the motor is 138 A.

Question: 8

A 3-phase, 480 V, 60 Hz, 4-pole induction motor has a full-load efficiency of 92% and a full-load power factor of 0.85. What is the approximate efficiency of the motor at 75% of full load?

- A. 90%
- B. 91%
- C. 92%
- D. 93%

Answer: B

Explanation: The efficiency of an induction motor typically increases as the load increases, reaching a maximum around the full-load point. For a motor with a full-load efficiency of 92%, the efficiency at 75% of full load is typically around 91%.

Question: 9

Which of the following is not a characteristic of a half-wave rectifier?

- A. The output waveform is pulsating and unidirectional.
- B. The output voltage is always positive.
- C. The average output voltage is equal to the peak value of the input voltage.
- D. The output waveform contains a large amount of ripple.

Answer: C

Explanation: In a half-wave rectifier, the average output voltage is not equal to the peak value of the input voltage. The average output voltage of a half-wave rectifier is approximately 0.318 times the peak value of the input voltage. This is due to the fact that the rectifier only allows one half-cycle of the input AC waveform to pass through, resulting in a pulsating unidirectional output.

Question: 10

A three-phase, 480 V, 60 Hz, 100 hp induction motor has the following parameters:

Stator resistance (R_s) = 0.2 Ω /phase

Rotor resistance (R_r) = 0.15 Ω /phase

Stator reactance (X_s) = 1.2 Ω /phase

Rotor reactance (X_r) = 1.0 Ω /phase

Magnetizing reactance (X_m) = 25 Ω /phase

The motor is operating at 0.85 power factor, lagging. What is the motor's full-load current?

- A. 100 A
- B. 120 A
- C. 140 A
- D. 160 A

Answer: B

Explanation:

To calculate the motor's full-load current, we need to first determine the equivalent circuit parameters and then use them to find the current.

The equivalent circuit parameters can be calculated as follows:

$$\text{Equivalent resistance (R}_{eq}\text{)} = R_s + R_r = 0.2 \, \Omega + 0.15 \, \Omega = 0.35 \, \Omega$$

$$\text{Equivalent reactance (X}_{eq}\text{)} = X_s + X_r = 1.2 \, \Omega + 1.0 \, \Omega = 2.2 \, \Omega$$

$$\text{Equivalent impedance (Z}_{eq}\text{)} = \sqrt{R_{eq}^2 + X_{eq}^2} = \sqrt{0.35^2 + 2.2^2} = 2.23 \, \Omega$$

$$\text{Power factor} = \cos(\text{atan}(X_{eq}/R_{eq})) = \cos(\text{atan}(2.2/0.35)) = 0.85 \text{ (lagging)}$$

The full-load current can be calculated as:

$$\text{Full-load current} = (100 \text{ hp} \times 746 \text{ W/hp}) / (\sqrt{3} \times 480 \text{ V} \times 0.85) = 120 \text{ A}$$

Therefore, the motor's full-load current is 120 A.

Question: 11

In a balanced three-phase system, the line voltage is 13.8 kV and the total apparent power is 20 MVA. If the power factor is 0.9 lagging, what is the line current?

- A. 679 A
- B. 836 A
- C. 940 A

D. 1099 A

Answer: B

Explanation: $S = \sqrt{3} * VL * IL$

$20,000,000 = \sqrt{3} * 13,800 * IL$

$IL = 20,000,000 / (\sqrt{3} * 13,800) = 836 \text{ A}$

Question: 12

What is the purpose of cold cranking amps (CCA) in a battery specification?

- A. Measure the battery's capacity in ampere-hours
- B. Indicate the maximum current the battery can provide
- C. Determine the battery's ability to start an engine in cold weather
- D. Represent the battery's internal resistance

Answer: C

Explanation: The cold cranking amps (CCA) specification for a battery indicates its ability to start an engine in cold weather. CCA measures the current a battery can deliver for 30 seconds at 0°F (-18°C) while maintaining a minimum voltage, which is important for reliable engine starting in low temperatures. The other options do not accurately describe the purpose of CCA - it does not measure capacity, maximum current, or internal resistance.

Question: 13

What is the main advantage of a boost converter over a linear voltage regulator?

- A. Higher efficiency
- B. Ability to produce an output voltage higher than the input voltage
- C. Smaller size and weight

D. All of the above

Answer: B

Explanation: The primary advantage of a boost converter over a linear voltage regulator is the ability to produce an output voltage that is higher than the input voltage. This makes boost converters useful for applications where the load requires a higher voltage than the available power source can provide.

Question: 14

A 3-phase, 60 Hz, wye-connected, 4,160 V generator is supplying power to a 3-phase, 60 Hz, delta-connected load. The generator line current is 100 A. What is the load kVA?

- A. 718 kVA
- B. 743 kVA
- C. 780 kVA
- D. 798 kVA

Answer: B

Explanation:

To find the load kVA, we need to use the formula:

$$S = \sqrt{3} \times V \times I$$

Where:

S = Apparent power (in kVA)

V = Line voltage (4,160 V)

I = Line current (100 A)

Since the generator is wye-connected and the load is delta-connected, the line voltage on the load side is the same as the phase voltage on the generator side, which is 4,160 V.

Substituting the values, we get:

$$S = \sqrt{3} \times 4,160 \text{ V} \times 100 \text{ A}$$

$$S = 743 \text{ kVA}$$

Therefore, the load kVA is 743 kVA.

Question: 15

A three-phase, 460V, 60 Hz, 4-pole induction motor has the following parameters:

$$\text{Stator resistance (R}_s\text{)} = 0.8 \ \Omega$$

$$\text{Rotor resistance (R}_r\text{)} = 0.6 \ \Omega$$

$$\text{Stator reactance (X}_s\text{)} = 2.0 \ \Omega$$

$$\text{Rotor reactance (X}_r\text{)} = 1.8 \ \Omega$$

$$\text{Rated power} = 100 \text{ HP}$$

$$\text{Rated speed} = 1800 \text{ rpm}$$

Assuming the motor is operating at full load, what is the phase current of the motor?

- A. 72 A
- B. 76 A
- C. 80 A
- D. 84 A

Answer: A

Explanation:

To calculate the phase current of the induction motor at full load, we can use the following formula:

$$I_{\text{phase}} = I_{\text{line}} / \sqrt{3}$$

Where:

I_{phase} = Phase current (A)

I_{line} = Line current (A)

From the previous question, we found that the line current at full load is 124 A.

Substituting the value, we get:

$$I_{\text{phase}} = 124 \text{ A} / \sqrt{3}$$

$$I_{\text{phase}} = 71.6 \text{ A}$$

Therefore, the phase current of the motor at full load is approximately 72 A.

Question: 16

A warehouse has an area of 150 ft x 250 ft and requires an average illuminance of 20 FC. The luminaires are mounted at a height of 30 ft and have a light loss factor of 0.75. What is the minimum total lumens output required from the lighting fixtures?

- A. 180,000 lumens
- B. 210,000 lumens
- C. 240,000 lumens
- D. 270,000 lumens

Answer: B

Explanation: To calculate the minimum total lumens output required, we can use the Lumen method:

Total Lumens = (Desired Illuminance × Area) / (Luminaire Efficiency × Light Loss Factor)

Given information:

Warehouse area: $150 \text{ ft} \times 250 \text{ ft} = 37,500 \text{ sq ft}$

Desired average illuminance: 20 FC

Luminaire mounting height: 30 ft

Light loss factor: 0.75

Step 1: Calculate the Luminaire Efficiency using the mounting height.

Luminaire Efficiency = 0.40 (for a mounting height of 30 ft)

Step 2: Calculate the total lumens required.

Total Lumens = $(20 \text{ FC} \times 37,500 \text{ sq ft}) / (0.40 \times 0.75) = 208,333 \text{ lumens}$

Rounding up, the correct answer is B) 210,000 lumens.

Question: 17

Which of the following is a common application for a Type 3 SPD?

- A. Service entrance protection
- B. Distribution panel protection
- C. Receptacle-level protection
- D. All of the above

Answer: C

Explanation: Type 3 SPDs are typically used for receptacle-level protection, providing surge protection for individual electronic devices or equipment.

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