Motor Controls, Transformers & Power Systems - 136 hours

Motor Controls & Power Quality

This will be an instructor-led class building on the concepts of our Advanced AC Motor Controls Class. The primary learning objective of this program is for the student to further advance his understanding of Motor Controls and associated devices as they apply to the industrial world. The student will be taking an in-depth look into the applications and the associated reflected effects of Variable Frequency Drives, Motors, Transformers & other Non-Linear loads typical in use in an industrial environment.

Key areas to be reviewed are as follows:

- Power Characteristics
- Power Quality Problems
- Power Measurements
- Effects of Poor Power Quality
- Power Transmission and Distribution
- Building Distribution Systems
- Power Conditioning and Protection

In addition, we cover detailed methods to analyze power system issues through our classic hands-on approach of using of state-of-the-art Dranetz & Fluke test equipment. We have also made extensive investments in our ability to create and generate power disturbances that are associated with the use of VFD motor controls and nonlinear loads. This will greatly enhance the student's ability to recognize, debug and analyze these signature issues in today's complex power systems and ultimately problem solve VFD, Motors and other similar industrial device failures.

Transformers, Line Reactors and Electrical Noise Mitigation

The students will also be studying VFD related power / noise mitigation techniques and applications including the study and use of transformers, filtration, and line reactors.

Key areas to be reviewed are as follows:

- Transformer Magnetism and Electromagnetism
- Transformer Operating Principles
- Transformer Electrical Safety
- Transformer Connections
- Harmonics and Inter Harmonics
- Power Generation and Distribution
- Reactors and Isolation Transformers
- Autotransformers & Controls Transformer
- Buck-Boost Transformers
- Special Transformers
- Special Transformer Connections
- Transformer Selection and Installation
- Transformer Maintenance and Troubleshooting

VFD Testing, Measurement & Experimentation

The student will be evaluating a VFD Motor system using both an inverter rated motor and a non-inverter rated motor. Student will wire, tune and commission a VFD motor control system using a three phase AC induction motors as described above and both an AB 525 VFD as well as an Automation Direct GS21VFD Drive.
The key area's cover are as follows:

Drive input

Measure input voltage and current to quickly see whether values are within acceptable limits by comparing the variable frequency drive's (VFD), also known as a variable speed drive (VSD) or adjustable speed drive (ASD), nominal rated voltage to the actual supplied voltage. The student will then check the input current to determine if the current is within the maximum rating and the conductors are suitably sized. Student will also measure harmonic distortion and determine if it's within an acceptable level by visually inspecting the waveform shape and by reviewing the total harmonic distortion and individual harmonics.

Voltage and current unbalance

Student will voltage unbalance at the input terminals of the VFD to determine if the phase unbalance is not too high (> 6-8 %), and that the phase rotation is correct. Student will also measure the current unbalance, as excessive unbalance may indicate a drive rectifier problem.

VFD harmonic measurements

Student will measure VFD Harmonic to determine if excessive harmonics are present as harmonics and intra harmonics not just a threat to your rotating machines but also to other equipment connected to the electrical power system. The student will use specialized test equipment to discover the presents of harmonics of the motor-drive and the effects of inverter switching electronics.

DC bus

Student will measure and verify proper VFD buss voltages, in a VFD the conversion of AC to DC inside the drive is critical, having the correct voltage and adequate smoothing with low ripple is required for the best drive performance. High ripple voltage may be an indicator of failed capacitors or incorrect sizing of the connected motor. Students will measure the DC bus performance dynamically while a load is applied.

Drive output

Students will check the output of the inverter drive focusing both on voltage to frequency ratio (V/F), and voltage modulation. When high V/F ratio measurements are experienced, the motor may overheat. With low V/F ratios, the connected motor may not be able to provide the required torque at the load to sufficiently run the intended process.

Voltage modulation

Students will take measurements of the Pulse Width Modulated signal to check for high voltage peaks which can damage motor winding insulation. The rise time or steepness of impulses is indicated by the dV/dt reading (rate of voltage change over time), this should be compared to the motor's specified insulation. The measurements can also be used to measure switching frequency to identify whether there is a potential issue with electronic switching.

Motor input

Student will measure and ensuring that correct voltage is being supplied at the motor input terminals, and the selection of cabling from drive to the motor is sized correctly as incorrect cabling selection can result in both drive and motor damage due to excessive reflected voltage peaks. Student will verify that the current present at the input terminals is within the motor rating as over current condition could cause the motor to run hot, decreasing the life of the stator insulation which can result in the early failure of the motor.

Motor shaft voltage

The student will measure voltage pulses from the variable frequency drive which can couple from a motor's stator to its rotor, causing a voltage to appear on the rotor shaft. Student will see that this rotor shaft voltage can easily exceeds the insulating capacity of the bearing grease, flashover currents (sparking) can occur, causing pitting and fluting of the motor bearing race, damage that can cause a motor to fail prematurely.

FLIR Thermal Imaging

Using the VFD system described above the student will learn through practical lab examples that heat is the primary cause of VFD & Motor failures and can be quickly identified using Flir Thermal Imagining. Electrical fault finding can be made simple even with low voltage systems as they give off excessive heat when they break down.

Key areas covered are as follows:

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Electrical inspections with a Flir Thermal Imager will ensure the student can identify and resolve:

- Locate hot or loose connections.
- Locate overloaded circuits.
- Locate overloaded motors.
- Locate motor being subjected to high harmonics.
- Locate Load Imbalances.

Initial signs of failure

Student will use thermal imaging camera to scan looking for hot spots on motor or VFD electrical systems that could indicate a potential problem.

Diagnose the source of the problem

Students will use analysis features such as in-camera temperature analysis to identify thermal issues on motor and drives.

Demonstrate that it is repaired

Student will learn to use thermal images as visual proof that a fault existed and was properly repaired.

Textbooks being used in this class:

1. Power Quality Measurement & Troubleshooting ATP
2. Power Quality Analysis Dranetz NJATC
3. Handbook of Power Signatures 2nd Edition
4. Dranetz Field Handbook for Energy Management
5. Dranetz Handbook for Power Quality
6. Transformers Principles and Applications
7. Motor's 2nd Edition NJATC

Instrumentation being used in this class:

1. Dranetz HDPQ PQA
2. Dranetz 4300 PQA
3. Fluke Thermal imaging camera
4. Fluke MDA 550 MDA
5. Fluke 87v lo
6. Fluke 375-FC Current meter
7. Digital Oscilloscope

Motor Drive Simulator Hardware

1. Power Flex 525 Drives
2. Automation Direct GS21 Drives.
3. Both inverter rated and non-inverter rated Induction motors.

Transformer Simulator Hardware

1. Auto transformer
2. Buck-Boost Transformer
3. Isolation Transformer
4. Control Transformer