Industrial Power System Design Fundamentals

LEARNING OUTCOMES

Safety, reliability, availability, maintainability, and cost effective optimal designs are key aspects of interest to anyone who engineers, services, and operates industrial plants and facilities. The Industrial Power System Design Fundamentals course is a comprehensive training solution that is designed to accommodate and deliver many aspects of the basic knowledge for proper designing of such an industrial power systems. If you are an experienced person, the course can refresh your knowledge of proper design and improve your skills. If you are a beginner, the course can help you understand, plan, and implement a proper design approach. Some of the learning outcomes of this course are the following:

- Helps you familiarize with the basic elements of industrial power systems such as substations, substation apparatus, switchgears, motor control centers, transformers, motors, generators, VFDs, fuses, circuit breakers, etc. .
- Increases your awareness of applicable standards, codes, and regulations in the area of industrial power systems design.
- Apply general industry and IEEE standards to your design.
- Provides you with a reliable procedure to plan and lead through a design for power systems.
- Increases your proficiency for calculating and specifying the components of industrial power systems.
- Familiarize you with electric substations and their layout and components.
- Help you select proper conductors, apply derating factors, and complete voltage drop calculations.
- You will understand the basics (terminology and methodology) of short circuit, protective device coordination, arc flash, power factor, and harmonics analysis.
- Familiarize you with power studies commonly used in industry such as load flow and transient stability studies. Ultimately, with advancing your knowledge of good engineering practices, you would be able to implement more cost-effective installations / maintenance by reducing rework and applying better practices.

COURSE OUTLINE - 2 DAYS

Day 1

Overview of the Industrial Power Systems

- Course objectives
- Industrial power systems definitions
- Elements of industrial power systems

Codes and Standards

- CSA codes and standards

- National and provincial codes
- Authorities having jurisdictions regulations and requirements
- IEEE standards
- NFPA standards
- Other standards and recommended practices
- Manufacturer’s data

System Planning

Basic Design Considerations

- Safety
- Operating and design limits for electric systems
- Reliability of plant primary electric supply service
- Reliability of plant distribution system

1. Reliability data for electrical equipment
2. Reliability analysis and total owning cost
3. Calculation procedure

- Simplicity of operation
- Voltage – classes, selection considerations and regulation
- Maintenance
- Flexibility
- First cost

System Planning Procedure

- Load definition and forecasting

1. Load survey
2. Load requirements and characteristics
3. Demand
4. Forecasting and planning
5. Special loads
6. Preparing a load list

- Plant distribution system
- Equipment locations
- Plant utilization voltage
- Primary utility supply service
- In-house generation
- Single-line diagram
- Short-circuit analysis
- Protective and protective device coordination
- Communications
- Maintenance
- Adequate records

- Codes and standards

Plant Distribution Systems

- Radial systems
- Secondary selective systems
- Network systems (including in-house generation)

Substations

- Types of substations
- Indoor vs outdoor
- Elements of a typical substation
- Equipment selection
- Single-line diagrams
- Substation layout and equipment spacing
- Primary and secondary protective devices
- Grounding systems

Conductors / Cable Systems / Busways

- Conductors per CEC
- Conductor materials (copper vs. aluminum)
- Conductor ampacities
- Conductor sizing
- Derating factors
- Voltage drop calculation
- Cable design considerations
- Cables LV vs. MV
- Cable ratings – electrical design criteria
- Typical busways

Cable Trays

- Cable trays per CEC
- Definitions and classes
- Different materials
- Cable tray sizing
- Cable tray installations

Electrical Equipment and Selection Criteria

- General selection specifications
- Equipment ratings
- Equipment nameplate data

- Transformers (distribution and power)
- Unit substations
- Generators
- Switchgears (MV – LV, metalclad vs. metal enclosed)
- Power distribution boards
- Power distribution centers
- Motors
- Motor Control Centers (elements, IEC vs. NEMA)
- Adjustable speed drives
- Circuit breakers (molded case vs. power)
- Substation apparatus

1. Instrument and voltage transformers
2. Lightning/surge arresters
3. Circuit breakers
4. Reclosers
5. Disconnect switches
6. Capacitor banks

Grounding Design

- Objectives of grounding and bonding
- Codes and standards
- Grounding and bonding per CEC
- Equipment grounding and system grounding
- Ground fault
- Major grounding systems
- Types of industrial system grounding

1. Ungrounded
2. Solidly grounded
3. Low resistance grounding
4. High resistance grounding

- NGR calculation
- Software design programs

Power Factor

- Definition of power factor
- Formulas
- Why maintaining a high power factor?
- Power factor leading and lagging concepts
- Typical plant power factors
- Equipment power factors
- Power factor improvements techniques

1. Controlling vars using capacitors
2. Synchronous motors

- Improving power factor - Calculation methods

DAY TWO

Short-Circuit Current Calculations

- Objectives of short circuit calculations
- Codes and standards
- Types of short circuits
- Sources of fault currents
- Fault currents (symmetrical and asymmetrical)
- System Modeling

1. Sources
2. Transformers
3. Motors

- Short circuit calculation - detailed procedure

1. Per unit system
2. Four step calculation

- Fuses vs. circuit breakers
- Momentary vs. interrupting vs. close and latch
- Example of short circuit calculation
- Software programs (ETAP, Easy Power, SKM)
- Procedure for short circuit calculation using software programs

Protective Devices Coordination

- Objectives of protective devices and relay coordination
- Codes and standards
- Fundamentals of circuit protection (design considerations)
- Fuses, circuit breakers, protective relays - selection and use
- Principals of electrical system coordination
- Substation protection
- Transformer, motor, generator, capacitor bank protections
- Typical TCCs (fuses, circuit breakers, transformers, cables, motors, etc.)
- Software programs (ETAP, Easy Power, SKM)
- Procedure for short circuit calculation using software programs
- Example of protective device coordination

Arc Flash Analysis

- Objectives of Arc Flash analysis
- Codes and standards
- Electrical hazards

- Definitions
- Arc Flash calculations and applicable software programs
- Methods of Arc Flash mitigation

1. Equipment specifications (Arc resistant equipment, etc.)
2. Design considerations
3. Proper protective devices and relay coordination
4. PPE categories

- Arc Flash labels

Harmonics Analysis

- Overview and objectives of harmonic analysis
- Definitions of harmonics
- Sources of harmonic currents
- Harmonic distortion factor
- Effects of harmonics on

1. Power System
2. Loads
3. communication

- Harmonic analysis
- Harmonic mitigation techniques

1. Shunt filters
2. Multipulse static power converters – phase shifting transformers
3. Harmonic current injection

Power System Studies and Analysis Overview

- Short-circuit analysis
- Relay and protective devices coordination study
- Load-flow analysis
- Motor-starting study
- Power-factor study
- Harmonic analysis
- Transient stability study
- Switching-transients analysis
- Reliability analysis
- Power quality study
- Cable ampacity analysis
- Ground-mat studies

Lighting Design

- Objectives of lighting design
- Codes and standards
- Definitions
- Various lighting sources
- Indoor vs. outdoor
- Lighting controls

Cost Estimation

- Classes of estimates
- Sample cost types:

1. Equipment and material costs
2. Installation costs
3. Engineering costs
4. Direct costs vs. in-direct costs
5. Other costs
6. Contingencies
7. Management costs

- Cost estimate preparation

1. Bill of Materials
2. Labour hours
3. Tasks / activities

INSTRUCTOR

Mark Moosaei, B.A.Sc., M.A.Sc., PMP, P.Eng. – Principal, Rastin Engineers Inc.

Mark Moosaei graduated with B.A.Sc. in electrical engineering from the Isfahan University of Technology in 1993, and obtained M.A.Sc. Degree from the Concordia University, Montreal, in 2003. Mark is a principal engineer with Rastin Engineers, and has over 25 years of experience working for major EPCM consulting engineering firms in Canada and Internationally.

Mark's areas of expertise includes designing, commissioning, and managing electrical, instrumentation, and control systems for Port and Terminal, Mining, Water and Wastewater, Oil and Gas, Utility, Pulp and Paper, and Metal Refining. His expertise also includes practical experience with industrial power distribution systems, emergency systems, analysis software, motor controls, VFDs, PLCs, and HMIs. Mark has a thorough knowledge of the Canadian Electrical Code, industry standards and safety codes.

Mark is a Project Management Professional (PMP) and registered electrical engineer (P.Eng.) in British Columbia and Alberta. He has published academic papers on the topic of control systems with the Institute of Electrical and Electronics Engineers (IEEE).

WHO SHOULD ATTEND

Different levels of electrical professionals such as engineers, engineers-in-training, technologists, designers, project managers, department managers and supervisors, as well as any other individual who wants to refresh their knowledge of the industrial power system design. Maintenance engineers, who are interested in industrial power systems design, can also benefit from the course.

WHEN & WHERE

T.B.D.

REGISTRATION FEES

CAD $775 + GST includes hardcopies of the 2-day course presentation materials, and refreshments and lunch for both days.

Get $50 off the price for new university/college graduates and students. The $50 amount will be refunded after the successful completion of the course.

For companies, register 3 persons and get the 4th person registration free of cost.