OVERALL ASSIGNMENT:

Design the electrical distribution system for the location described in the "Site Details" section of this document. Your design must adhere to the general standards specified within the National Electric Code (NEC) along with any other applicable good design practices. You must, for each decision that you make, document and provide the reasoning leading to that decision, and you must provide citations to the references(if any) that you utilized while making that decision.

Your final design must be submitted in the form of a printed formal report, the details of which are specified later in this document.

Evaluation and grading of your distribution system will be based on several factors, including

- Adherence to the design standards provided by the NEC and other sources,
- Practicality of design,
- Completion of design,
- Thoroughness of documentation,
- Quality of formal report.

This assignment is to be completed on an **individual basis** with no (direct or indirect) assistance from any other person, except that you may "consult" with the course instructor during the design and decision-making process.

The Final Report is due by NOON on Thursday the 7th of December.

NO REPORTS WILL BE ACCEPTED AFTER 8:00PM ON THURSDAY THE 8TH OF DECEMBER.
A grade of zero will be assigned to any project for which the final report is not received by 8pm on the 7th of December.

PROJECT OVERVIEW:

You will be designing the electrical distribution system for the small commercial facility that is described in the next section this document. Your design will cover all of the entire distribution system from the point of service to the branch circuit outlets, including (but not limited to) the main building transformer, the service entrance conductors, the required switchboards and/or panelboards, the required feeder/branch circuit conductors and the required protective devices.

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PROJECT DETAILS:

Overall Facility

The overall facility consists of a small commercial building located on a small plot of land. The distribution system design will primarily focus on the building, which contains both office and warehouse/workshop space. The only parts of the distribution system that are external and unattached to the building are the service transformer and service entrance conductors, two light-poles (to illuminate the parking area), and a light-up entrance sign.

General Electrical Requirements

The electric distribution system for the facility must be designed to adequately provide power for the facility's lighting load, the convenience receptacles and the common appliance-type loads that they will serve (determined from the proposed room allocations shown on the building plan), and the known loads that will exist at various locations throughout the facility as specified on the ***"Equipment List / Ratings"*** sheet that was provided individually to each student during the lecture sessions.

Both the branch circuit and feeder circuit designs must adhere to the requirements defined in the NEC. All conductor types/sizes/lengths, over-current protection devices, conduit sizes, electrical panels, and other required system components must be specified as part of the overall system design. The placement of all receptacles and switches within the building must also be specified as part of the system design.

Furthermore, a complete set of load calculations, short-circuit current calculations and voltage-drop calculations must be performed and documented within the final report.

Note that additional panelboards that supply lighting or other loads may be located external to the building's main electrical room if needed/desired.

Also note that, although grounding conductors are an important part of any system design, they are beyond the scope of what will be covered in this course and they can be omitted from the distribution system design.

Service

The point-of-service for the facility is located at the primary terminals of the 3Φ service transformer, the secondary windings of which are rated at 208V. A service-lateral will originate from the secondary terminals of the transformer and it will enter the NE corner of the building's main electrical room. Note that, although the location of the service transformer is not shown on the building plan, the length of the service lateral is specified on the ***"Equipment List / Ratings"*** sheet.

For purposes of voltage-drop calculations, assume that the secondary windings of the service transformer maintain rated voltage at their terminals, and for purposes of SC-current calculations, assume that the point of service is supplied by an infinite-bus.

Load Information

Electric Appliances/Loads

The proposed facility includes a variety of appliances and other types of loads (such as an air-compressor), the locations and ratings of which are either shown on the building plan or specified on the ***"Equipment List / Ratings"*** sheet. Additionally, other unspecified appliances and loads should be predicted at various locations throughout the building based upon the types of rooms present. The electric distribution system must provide for both the specified loads and the predicted loads, either by means of the branch circuits supplying the convenience receptacles or by branch circuits dedicated to those loads.

For example: The break-room is specified to contain a microwave oven, a coffee maker and a refrigerator. On the other hand, offices typically contain desktop computers. Desktop computers are not specified in this document, but their existence should be predicted.

Convenience Receptacles

Convenience receptacles should be placed within all habitable areas of facility in a logical manner that adequately provides for the needs of the various areas while also adhering to any specific requirements found in the NEC. It is expected that all convenience receptacles will be located on the walls of the building.

Lighting Requirements

The location and type of luminaires used for general lighting within the building and the branch circuits used to supply the building lighting (including switch positions) must be defined as part of the electric distribution system design.

The branch circuits used to supply all of the exterior lighting fixtures must also be defined as part of the system design. Note that the ratings and the conductor lengths for all of the facility's required exterior lighting fixtures (non-building mounted) are provided in the assigned equipment list.

Additional Information / Addendums:

Issues may arise during the weeks immediately following the publication of this document that will require additional information from the instructor or clarification about the specific details of this project and/or the requirements for the final report. Any additional information or clarifications that may change or increase the requirements of this project must be provided by the instructor no later than the end of lecture on Tuesday the 14th of November, after which the requirements of this project are assumed to be final.

Milestone:

9:30am Nov. 2nd – Each student must submit:

1) A set of "rough draft" **electrical diagrams** showing the circuit connections and home-runs for all of the:

- General Purpose Receptacles
- Dedicated Loads
- Lighting Circuits (including switch placement)

2) A set of initial **panel schedules** (that show CB ratings and connected loads)

3) A set of initial **wiring schedules** (that show # of conductors, sizes and lengths).

Although the submitted documents do not have to be of "formal report" quality, they must be neat and complete.

Documentation Requirements (Formal Report):

Each student will submit an individual-written, formal report that documents the entire design of their electrical distribution system. This includes (*but is not limited to*):

A complete set of tables and drawings that detail the system layout, the conductor types/sizes/lengths, the overcurrent protection device ratings, the receptacle/switch locations, the panelboard ratings and layouts, the wiring and equipment schedules, the conduit sizes and lengths, and any other information required for the general installation of the system.

The system drawings may be broken down into individual drawings that show:

- The Branch Circuits for the General Purpose Receptacles
- The Branch Circuits for the Dedicated Loads
- The Branch Circuits for the Interior Lighting (including Switch Locations)
- The Feeders and Switchboard/Panelboard Locations
- A One-Line Diagram that Documents the Distribution System's Overall Design

Furthermore, the report must include a descriptive analysis or narration of the entire design process, documenting any arbitrary decisions made during each step of that process and citing the references (if any) utilized for each decision-making step.

In order to complete this project, a variety of calculations must be performed in order to verify that any fault-current, voltage-drop, and/or other concerns specified within the NEC have been addressed by the system design. The motivation behind each set of calculations must be clearly stated and the results of the calculations must be tabulated and presented in a logical and well-organized manner.

Note that a set of sample calculations must be provided for each unique set of calculations that were performed during the completion of this design project. The sample calculations should be included within an appendix and the end of the formal report.

The **entire report**, including all text, calculations, tables, and figures, **must be typed or otherwise electrically generated**. The only exception to this rule is the wiring diagrams that show the branch and feeder circuits on the building plan, which may be composed of hand-drawn circuits on building plans that are printed on 11"x17" or larger size paper.

FINAL REPORT CHECKLIST:

The following checklist is provided as a partial reference for completion of the final report. Note that the checklist is **not** an all-inclusive list of the required content for the report, and that the included items may not be shown in the order that they should appear within the final report.

Overall Report

- ☐ – The Report is Well-Written and Completely Checked for Errors
- ☐ – Table of Contents (Uniformly formatted, showing key (sub)sections and page numbers)
- ☐ – List of Tables/Figures (Uniformly formatted, showing titles and page numbers)
- ☐ – Introduction (Clearly summarizing overall project requirements / goals)
- ☐ – Narration (Describing the design process and documenting arbitrary decisions)
- ☐ – All Figures and Tables are assigned numerical identifiers and titles
- ☐ – All content electronically generated (typed/drafted) except for wiring diagrams
- ☐ – All hand-drawn wiring diagrams exceptionally neat (all print written in block letters, all straight lines drawn using a straight-edge, etc.)
- ☐ – Sample calculations provided (in appendix) for all performed/required calculations
- ☐ – All pages clearly labeled in proper order
- ☐ – All technical content is clearly described (ie. – a text-based description should be provided for all technical content that clearly describes the both the content itself and the importance of the content with respect to the scope of the project)
- ☐ – Conclusion (Well thought-out conclusion that summarizes overall project and results)
- ☐ – List of References
- ☐ – Appendices containing any necessary information

Specific Content

A Complete Set of Wiring Diagrams Showing:

- ☐ – Panel Locations
- ☐ – General Purpose Receptacle Circuits
- ☐ – Individual Branch Circuits
- ☐ – Lighting Circuits w/ Switch Locations

- ☐ – One-Line Diagram of Overall System (Service→Final OC Protection Devices)
- ☐ – Panel Schedules provided for each panel included in system (See example – PPT #8)
- ☐ – Wiring Schedules provided for each panel included in system (See example – PPT #8)
- ☐ – Conduit Schedules provided for each panel included in system (See example – PPT #8)
- ☐ – Luminaire Schedule provided
- ☐ – Distribution System Equipment List that documents all required system components
  Switch/Panelboards, Transformers, Conductors (sizes & total lengths), Circuit Breakers, Luminaires…
- ☐ – Results of SC Current Analysis Clearly Documented
- ☐ – Results of Voltage-Drop Analysis Clearly Documented
- ☐ – Load Calculations for transformers/feeders/panels clearly documented
  General lighting load considered along with branch-circuit loads?
- ☐ – Relevant Manufacturer's Data provided in appendices for reference?

Note that you may want to refer to pages 1-34 of the Electrical Plan Review document (EPR-1) by Bussmann for assistance when composing the final report.