

Electrical Low-Voltage Power & Lighting System Design



Comprehensive Guide to
Distribution of Power
and Lighting Using
AutoCAD, DIALux &
Design Calculations
Using Excel

 **AUTOCAD®**

DIALux

By: Eng. Mohammed Ayman



About the Coursebook

Have you ever asked yourself, what are the main factors that lead to a well-designed electrical system? Well, the answer is in this guidebook!

I used my design and site experience in this coursebook to make the power distribution system design as simple as possible. I have covered the major points that an electrical designer should know to deliver a well-designed lighting and power system project. You will be introduced to the most important engineering programs like AutoCAD and DIALux. You will be able to solve power-related calculations like voltage drop, cable sizing, breaker sizing, short circuit analysis and power factor capacitor sizing to deliver a safe design. Moreover, you will know how to protect your designed system from faults by studying earthing and lightning systems. I have explained every topic in this book with videos that show how the design is performed practically.





About the Author

I earned my degree from Eastern Mediterranean University (Turkey, North Cyprus) in B.S. Electrical & Electronic Engineering; shortly after, I began my career as an electrical site engineer in a mega-scale project in Qatar, which allowed me to monitor and supervise electrical site installations. Following that, I indulged in the design field of electrical low-voltage distribution systems and have accomplished more than ten projects in compliance with the national codes & international standards.

- Holding ABET Accreditation.
- Registered and accredited by the Engineering & Consulting Committee in Qatar.
- Accredited by Engineers Australia as a Professional Engineer.

1. Introduction	1
1.1. Introduction to the Course Content.....	1
2. Introduction to AutoCAD	4
2.1. Introducing AutoCAD Commands in Toolbars.....	5
2.1.1. Drawing Template	6
2.1.2. Draw Toolbar.....	7
2.1.3. Modify Toolbar	8
2.1.4. Annotation Toolbar.....	8
2.1.5. Layers Toolbar	8
2.1.6. Block Toolbar	8
2.1.7. Properties Toolbar.....	8
2.2. Drawing Shapes and Objects.....	9
2.2.1. Drawing Lines.....	10
2.2.2. Drawing Polylines	10
2.2.3. Drawing Circles	11
2.2.4. Drawing Arcs.....	11
2.2.5. Drawing Rectangles	12
2.2.6. Hatching Objects	13
2.2.7. Different Electrical Objects	14
2.3. Modify Toolbar	14
2.3.1. Moving, Rotating, and Copying.....	15
2.3.2. Mirroring	16
2.3.3. Trimming	16
2.3.4. Fillet.....	16
2.3.5. Stretching and Scaling.....	17
2.4. Blocks	17
2.4.1. Converting Different shapes into Blocks.....	18
2.4.2. Advantage of Converting Shapes into Blocks	18
2.5. Status Toolbar.....	19
2.5.1. Object Snap	19
2.5.2. Orthomode	20
2.5.3. Polar Tracking	20
2.5.4. Starting of an Electrical Project	21
2.6. End of Chapter Quiz	22
3. DIALux Evo	24
3.1. Introduction to DIALux Evo Version	24
3.2. Introducing DIALux Menu Toolbar Features.....	25
3.2.1. Starting a Project.....	25
3.2.2. Menu Toolbar	26
3.2.3. Construction Toolbar	26
3.2.4. Light Toolbar	27

3.2.5. Calculation Objects	28
3.2.6. Manufacturer Toolbar	29
3.2.7. 3D & Other Views	29
3.2.8. Documentation	30
3.3. Importing Architectural Plan from AutoCAD into DIALux	31
3.3.1. Preparation of Architectural Layout	31
3.3.2. Converting AutoCAD Format into DIALux	32
3.3.3. Importing Plan into DIALux	33
3.4. Preparation of Rooms Using Construction Toolbar	34
3.4.1. Drawing Room Plans	34
3.4.2. Drawing Room Elements & Apertures	35
3.4.3. Average Lux Input	36
3.4.4. Uniformity Level	37
3.4.5. False Ceiling	39
3.5. False Ceiling Types & Light Fixtures Selection	39
3.5.1. Types of Ceilings	40
3.5.2. Types of Light Fixtures	41
3.5.3. IP Ratings of Light Fixtures	42
3.6. Calculation of Lux Levels & Results	44
3.7. Documentation & Exporting to AutoCAD	45
3.7.1. Lux Result Report Preparation	45
3.7.2. Exporting DIALUX into AutoCAD Format	46
3.7.3. Pasting Exported Light Fixtures to AutoCAD	47
3.8. End of Chapter Quiz	48
4. Lighting Distribution	50
4.1. Folders Management and Arrangement	50
4.1.1. Electrical Systems Folders Arrangement	50
4.2. Normal Light Distribution	51
4.2.1. Light Symbols Legend	52
4.2.2. Distribution of Lights Inside Rooms	53
4.3. Emergency Light Distribution	54
4.3.1. Types of Loads	55
4.3.2. Distribution of Emergency Lights	57
4.3.3. Exit Lights & Slave Luminaires	58
4.3.4. Central Battery System	60
4.4. Light Switches	61
4.4.1. Types of Light Switches	61
4.4.2. Distribution of Light Switches	63
4.5. Connection of Lighting Wiring Circuits	65
4.5.1. Drawing Wiring Lines	65
4.5.2. Connecting Lights to Switches	67
4.6. Preparation of Lighting Legends	68
4.7. End of Chapter Quiz	69

5.	Power Distribution	71
5.1.	Gathering Information & Preparation of Power Plan.....	71
5.1.1.	Gathering Electrical Information from Architecture Department.....	71
5.1.2.	Gathering Electrical Information from Mechanical Department	72
5.1.3.	Locking AutoCAD Layers Power Plan	73
5.2.	Distribution of Wall Sockets & Floor Boxes	74
5.2.1.	Furniture & Power Sockets.....	75
5.2.2.	Floor boxes.....	76
5.2.3.	Wall Sockets.....	77
5.3.	Power Provisions for Mechanical Equipment.....	79
5.3.1.	Power for Air Conditioners	79
5.3.2.	Power for Water Heaters & Fans.....	81
5.4.	Types of Electrical Circuits.....	82
5.4.1.	Ring Main Circuits	83
5.4.2.	Radial Circuits	84
5.5.	Circuit Numbers of Loads.....	85
5.5.1.	Sockets Circuit Numbers	86
5.5.2.	Locating Distribution Boards	87
5.6.	Roof Power Provisions.....	88
5.6.1.	Isolators	88
5.6.2.	Weatherproof Sockets	90
5.7.	Electrical Rooms & Panel Boards.....	90
5.7.1.	Distribution of Panel Boards.....	91
5.7.2.	Selection of Electrical Rooms.....	92
5.8.	End of Chapter Quiz	94
6.	DB Schedules & Single Line Diagrams.....	96
6.1.	6.1. Creating a DB Schedule Using Excel Sheet	96
6.1.1.	Exploring Excel Preferences.....	96
6.1.2.	Defining DB Attributes	97
6.2.	6.2. Defining Schedule Equations in Excel	98
6.2.1.	Circuit Number Ways	99
6.2.2.	R Y B Phases	100
6.2.3.	Demand Factor	101
6.2.4.	Total Demand Load.....	102
6.2.5.	Total Connected Load	103
6.2.6.	Balancing Loads Equation	104
6.3.	6.3. Defining DB Schedule Loads in Excel.....	105
6.3.1.	Filling DB Schedule Headline.....	105
6.3.2.	Defining & Matching Loads with CAD Drawings	106

6.4.	Transferring a DB Schedule from Excel to AutoCAD.....	107
6.4.1.	First Method	108
6.4.2.	Second Method	108
6.5.	Single Line Diagrams	109
6.5.1.	HV to LV Generation, Transmission & Distribution of Power.....	109
6.5.2.	Interpreting a Single Line Diagram	110
6.5.3.	Interpreting a Single Line Diagram with a Backup Generator	112
6.5.4.	Design a Single Line Diagram in AutoCAD	113
6.6.	End of Chapter Quiz	115
7.	Low Voltage Design Calculations.....	116
7.1.	Low Voltage Transformers	116
7.1.1.	Types of LV Transformers	116
7.1.2.	Types of Transformers Connections	118
7.1.3.	Transformer Size Calculation	119
7.2.	Backup Generators.....	122
7.2.1.	Diesel Backup Generators	123
7.2.2.	Portable Generators.....	124
7.2.3.	Generator Size Calculation	125
7.3.	Cables and Wires	127
7.3.1.	Selection of Cables and Wire Types.....	127
7.3.2.	Cable Size Calculation	131
7.4.	Circuit Breakers	133
7.4.1.	Types of Circuit Breakers	133
7.4.2.	Circuit Breaker Size Calculation	138
7.5.	Voltage Drop.....	141
7.5.1.	Voltage Drop Causes, Effects & Mitigation.....	141
7.5.2.	Permitted Voltage Drop Percentage	143
7.5.3.	Voltage Drop Calculation.....	144
7.6.	Short Circuit Current (SCC)	147
7.6.1.	Types, Causes & Effects of Short Circuit Faults	148
7.6.2.	Short Circuit Analysis & Calculation	150
7.7.	Calculating Voltage Drop & Short Circuit Current in Excel (Videos).....	154
7.8.	Power Factor Correction.....	154
7.8.1.	Types of Power.....	155
7.8.2.	Types of Loads	156
7.8.3.	Resistive, Inductive & Capacitive Loads	157
7.8.4.	Capacitor Bank Size Calculation	158
7.9.	End of Chapter Quiz	162

8.	Earthing & Lightning Systems	164
8.1.	Earthing System	165
8.1.1.	Types of Earthing Systems	168
8.1.2.	Earthing Cable Size Calculation	171
8.1.3.	Earthing System Calculation	172
8.1.4.	Components of Earthing System.....	177
8.2.	Lightning Protection System.....	178
8.2.1.	Components of LPS.....	179
8.2.2.	Types of LPS.....	180
8.3.	Lightning Risk Assessment	183
8.3.1.	Lightning Protection Levels (LPL)	187
8.3.2.	Lightning Design Considerations	188
8.4.	Earthing & Lightning Systems Design in AutoCAD	191
8.4.1.	Ground Floor Design.....	191
8.4.2.	Roof Floor Design.....	192
8.5.	End of Chapter Quiz.....	193
9.	Quiz Answers	194