

HIGHER TECHNICAL INSTITUTE

ELECTRICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

DESIGN OF THE ELECTRICAL SERVICES OF A
LUXURY HOUSE

E1428

STELIOS CHRISTOFI

JUNE 2008

**DESIGN OF THE ELECTRICAL SERVICES OF A
LUXURY HOUSE**

**PROJECT SUBMITTED BY:
CHRISTOFI STELIOS A.**

**TO THE DEPARTMENT OF ELECTRICAL
ENGINEERING OF THE HIGHER TECHNICAL
INSTITUTE
NICOSIA-CYPRUS**

**IN PARTIAL REALISATION OF REQUIREMENTS FOR
THE DIPLOMA OF**

**TECHNICIAN ENGINEER
IN
ELECTRICAL ENGINEERING
JUNE 2008**

**PROJECT SUPERVISOR: Mr George Kourtellis
LECTURER OF THE ELECTRICAL ENGINEERING
DEPARTMENT, H.T.I**

HIGHER TECHNICAL INSTITUTE	PROJECT NO 3755
----------------------------------	--------------------

CONTENTS

ACKNOWLEDGEMENTS.....	8
SUMMARY.....	9
INTRODUCTION.....	10
<u>CHAPTER 1</u>	
ILLUMINATION DESIGN	12
1.1 Introduction	12
1.2 Definitions and units.....	12
1.3 Rules for energy efficient lighting.....	13
1.4 Methods of illumination calculations	14
1.4.1 <i>Point by point method</i>	14
1.4.2 <i>Lumens method</i>	14
Procedure of the Lumen method	15
1.6 Typical calculation	16
1.7 Tables of Illumination Design	18
<u>CHAPTER 2</u>	
LIGHTING CIRCUIT DESIGN	21
2.1 Introduction	21
2.2 Typical calculations.....	21
2.2.1 <i>Calculation of live conductor</i>	21
2.2.2 <i>Voltage drop</i>	22
2.2.3 <i>Shock Protection</i>	23
2.2.4 <i>Thermal Constrains</i>	24
2.2.5 <i>Calculation of conduit diameter</i>	24
2.3 Table of Results	28
<u>CHAPTER 3</u>	
SOCKET OUTLETS DESIGN	30
3.1 Introduction	30
3.2 Typical calculations.....	30
3.2.1 <i>Calculation of live conductor</i>	31
3.2.2 <i>Voltage drop</i>	31
3.2.3 <i>Shock protection</i>	32
3.2.4 <i>Thermal constrains</i>	33
3.2.5 <i>Calculation of conduit diameter</i>	33
3.3 Table of Results	34
<u>CHAPTER 4</u>	
FIXED ELECTRICAL APPLIANCES.....	35
4.1 Cooker Unit calculations	35
4.1.1 <i>Calculations for live conductor</i>	35
4.1.2 <i>Voltage drop</i>	36
4.1.3 <i>Shock protection</i>	37

4.1.4	<i>Thermal Constrains</i>	37
4.1.5	<i>Calculation of conduit diameter</i>	38
4.2	Washing machine calculations	39
4.2.1	<i>Calculations for live conductor</i>	39
4.2.2	<i>Voltage drop</i>	39
4.2.3	<i>Shock protection</i>	40
4.2.4	<i>Thermal Constrains</i>	41
4.2.5	<i>Calculation of conduit diameter</i>	41
4.3	Water Heater calculations.....	42
4.3.1	<i>Calculations for live conductor</i>	42
4.3.2	<i>Voltage drop</i>	43
4.3.3	<i>Shock protection</i>	43
4.3.4	<i>Thermal Constrains</i>	44
4.3.5	<i>Calculation of conduit diameter</i>	45
4.4	Refrigerator calculations.....	45
4.4.1	<i>Calculations for live conductor</i>	45
4.4.2	<i>Voltage drop</i>	46
4.4.3	<i>Shock protection</i>	46
4.4.4	<i>Thermal Constrains</i>	47
4.4.5	<i>Calculation of conduit diameter</i>	47
4.5.1	<i>Calculations for live conductor</i>	48
4.5.2	<i>Voltage drop</i>	48
4.5.3	<i>Shock protection</i>	49
4.5.4	<i>Thermal Constrains</i>	50
4.5.5	<i>Calculation of conduit diameter</i>	50

CHAPTER 5

MOTOR CIRCUITS.....	52	
5.1	Introduction	52
5.2	Water pump calculations	52
5.2.1	<i>Calculations for live conductor</i>	52
5.2.2	<i>Voltage drop</i>	53
5.2.3	<i>Shock protection</i>	53
5.2.4	<i>Thermal Constrains</i>	54
5.2.5	<i>Calculation of conduit diameter</i>	55
5.3	Hot water recirculation pump calculations	55
5.3.1	<i>Calculations for live conductor</i>	55
5.3.2	<i>Voltage drop</i>	56
5.3.3	<i>Shock protection</i>	56
5.3.4	<i>Thermal Constrains</i>	57
5.3.5	<i>Calculation of conduit diameter</i>	58
5.4.1	<i>Calculations for live conductor</i>	58
5.4.2	<i>Voltage drop</i>	59
5.4.3	<i>Shock protection</i>	59
5.4.4	<i>Thermal Constrains</i>	60
5.5	Garage motor calculations	61
5.5.1	<i>Calculations for live conductor</i>	61
5.5.2	<i>Voltage drop</i>	62

5.5.3	<i>Shock protection</i>	62
5.5.4	<i>Thermal Constrains</i>	63
5.5.5	<i>Calculation of conduit diameter</i>	64
5.6	Table of Results	64
CHAPTER 6		
SWIMMING POOL		
6.1	Introduction	65
6.2	Water pump calculations	65
6.2.1	<i>Calculations for live conductor</i>	65
6.2.2	<i>Voltage drop</i>	66
6.2.3	<i>Shock protection</i>	66
6.2.4	<i>Thermal Constrains</i>	67
6.2.5	<i>Calculation of conduit diameter</i>	68
6.3	Underwater lighting	68
CHAPTER 7		
STORAGE HEATERS DESIGN		
7.1	Introduction	69
7.2	Selection of the units	69
7.3	Table of selection	70
7.4	Typical calculations	71
7.4.1	<i>Calculations for S/H 7 in Handy living room</i>	71
7.4.2	<i>Voltage drop</i>	71
7.4.3	<i>Shock protection</i>	72
7.4.4	<i>Thermal Constrains</i>	73
7.4.5	<i>Calculation of conduit diameter</i>	73
7.4.6	<i>Calculations for S/H 1 in living room</i>	74
7.5	Table of Results	76
7.6	Calculations of supply cables for D/B 6	77
7.6.1	<i>Calculations for live conductor</i>	78
7.6.2	<i>Voltage drop</i>	79
7.6.3	<i>Shock protection</i>	79
7.6.4	<i>Thermal Constrains</i>	80
7.6.5	<i>Calculation of conduit diameter</i>	81
7.6.6	<i>Calculations of supply cables for D/B 4</i>	81
7.6.7	<i>Distribution of loads</i>	82
7.6.8	<i>Calculations for live conductor</i>	83
7.6.9	<i>Voltage drop</i>	83
7.7	Table of Results	84
CHAPTER 8		
AIR CONDITION DESIGN		
8.1	Selection of the units	85
8.3	Typical calculations	86
8.3.1	<i>Dining room AC4 (Cassette type)</i>	86
8.3.2	<i>Voltage drop</i>	87
8.3.3	<i>Shock protection</i>	88

8.3.4 Thermal Constrains	88
8.3.5 Calculation of conduit diameter	89
8.4 Table of Results	89

CHAPTER 9

LIGHTNING PROTECTION DESIGN.....	91
9.1 Introduction	91
9.2 Lightning conductor	91
9.3 Effects of lightning strike	91
9.3.1 Electrical effects	91
9.3.2 Side Flashing	92
9.3.3 Thermal effects	92
9.3.4 Mechanical effects	92
9.4 Need of protection	92
9.5 Zone of protection	93
9.6 Down Conductors	93
9.7 Estimation of exposure risk	93

CHAPTER 10

TELEPHONE AND DATA DISTRIBUTION DESIGN.....	98
10.1 Introduction	98
10.2 Definition and terms	98
10.2.1 Internal telecommunication network	98
10.2.2 Telephone point	98
10.2.3 Distribution cable	98
10.2.4 Access cable.....	98
10.2.5 Main distribution case (MDC)	99
10.2.6 Distribution cases (DC).....	99
10.2.7 Strip connections	99
10.2.8 Subscriber line	99
10.2.9 Protector and fuse box.....	99
10.2.10 Block terminal box.....	99
10.2.11 Draw-in boxes.....	100
10.3 Earthing	100
10.3.1 Operational earth	100
10.3.2 Earthing arrangement for electronic telecommunication equipment....	100
10.3.3 Protection earth.....	100
10.3.4 Protection against lightning surges.....	100
10.4 Installation of the access cable	101
10.5 Installation of the conduits	101
DATA DISTRIBUTION DESIGN	106

CHAPTER 11

BONDING AND EARTHING.....	107
11.1 Introduction	107
11.2 Main Equipotential Bonding	107
11.3 Bonding Conductor.....	107

CHAPTER 12

INSPECTION AND TESTING.....	109
12.1 Introduction	109
12.2 Visual Inspection	109
12.3 Testing	109
12.3.1 Continuity of ring final circuit conductors	110
12.3.2 Continuity of protective conductors including all metallic parts	110
12.3.3 Insulation Resistance	110
12.3.4 Polarity Test	111

CHAPTER 13

DIVERSITY AND PHASE BALANCING	113
13.1 Swimming pool D/B 3	113
13.1.1 Calculations for live conductor	113
13.1.2 Voltage drop	114
13.1.3 Cross Sectional Area of Protective Conductor.....	114
13.1.4 Calculation of conduit diameter	114
13.2 Boiler room D/B 4	115
13.2.1 Calculations for live conductor	115
13.2.2 Voltage drop	116
13.2.3 Shock protection	116
13.2.4 Thermal Constrains	117
13.2.5 Calculation of conduit diameter	118
13.3 Basement D/B 1	118
13.3.1 Calculations for live conductor	119
13.3.2 Voltage drop	119
13.3.3 Cross Sectional Area of Protective Conductor.....	120
13.3.4 Calculation of conduit diameter	120
13.4 1 st Floor D/B 5	120
13.4.1 Calculations for live conductor	121
13.4.2 Voltage drop	121
13.4.3 Cross Sectional Area of Protective Conductor.....	122
13.4.4 Calculation of conduit diameter	122
13.5 MAIN D/B	122
13.6 Calculations for supply cable	123
13.6.1 Calculations for live conductor	124
13.6.2 Voltage drop	124
13.6.3 Cross Sectional Area of Protective Conductor.....	124
13.6.4 Cross Sectional Area of Equipotential Bonding Conductor.....	125
13.6.5 Cross Sectional Area of Supplementary Bonding Conductor	125
13.6.4 Calculation of conduit diameter	125

CHAPTER 14

SINGLE LINE DIAGRAMS.....	126
14.1 Boiler room (D/B 4)	126
14.2 Swimming Pool (D/B 3)	127
14.3 Basement (D/B 1)	128
14.4 1 st Floor (D/B 5)	129
14.5 Main D/B	130

CHAPTER 15

PHOTOVOLTAIC PANELS	131
15.1 Introduction	131
15.2 Selection and installation of panels	131
15.3 Selection of slope.....	132

CHAPTER 16

MATERIAL AND COSTING.....	137
16.1 Introduction	137
16.2 The Analytical method	137
16.3 Material cost	138
16.3.1 <i>Lighting circuits</i>	138
16.3.2 <i>Socket outlets</i>	139
16.3.3 <i>Fixed Appliances</i>	140
16.3.4 <i>Air conditions and Storage Heaters</i>	141
16.3.5 <i>Main switchgear and distribution boards</i>	142
16.3.6 <i>Lihgtning protection system</i>	143
16.3.7 <i>Telephone system</i>	144
16.3.8 <i>Data Distribution system</i>	144
16.3.9 <i>PV PANELS</i>	145
16.4 Costing Evaluation	146

CONCLUSIONS	147
-------------------	-----

REFERENCES	148
------------------	-----

APPENDICES	149
------------------	-----

DRAWINGS.....	316
---------------	-----

Appendices

Appendix 1: IEE REGULATIONS, TABLES AND CHARTS.....	150
Appendix 2: ILLUMINATION FITTINGS AND SPECIFICATIONS.....	177
Appendix 3: SWITCHGEAR SPECIFICATIONS	225
Appendix 4: FIXED APPLIANCES	248
Appendix 5: STORAGE HEATERS AND AIR CONDITION SPECIFICATIONS	259
Appendix 6: LIGHTNING CONDUCTOR EQUIPMENT AND SPECIFICATIONS	277
Appendix 7: PV PANELS SPECIFICATIONS	300
Appendix 8: DATA DISTRIBUTION EQUIPMENT AND SPECIFICATIONS....	304
Appendix 9: TELEPHONE SYSTEM EQUIPMENT AND SPECIFICATIONS	311

ACKNOWLEDGEMENTS

I would like to thank my project supervisor, Mr G. Kourtelli lecturer of the Electrical Engineering Department of H.T.I. for his valuable guidance and assistance for the completion of this project.

Also I would like to thank all the people who helped me in providing the necessary information, specifications, technical data, price lists and all the lecturers of H.T.I. who helped me and gave me valuable knowledge to complete the electrical engineering course.

SUMMARY

The purpose of this project is to examine and study the design of the electrical services of a luxury house. The project is carried out with responsibility and as real is possible as it is directly involved with the safety of people, livestock and property.

The whole design is carried out in accordance to the IEE wiring regulations 16th edition EAC and CYTA regulations.

The design of the electrical services of a luxury house is explained in detail to the various chapters of this project. The main body of the project is divided in 13 chapters in order to simplify the study of the project. At the end of the project appendices are included giving specifications for the devices and equipment used. Also the detailed architectural drawings are provided showing the locations of the equipment used.

INTRODUCTION

The house is consisted of a basement, a ground floor and one floor.

At the basement there is a parking place, the boiler room. The swimming pool engine room, one warehouse and two small rooms.

At the ground floor there are four rooms, three verantas, two bathrooms, one ware house, and the swimming pool.

The first floor is consisted of four bedrooms, one office, two bathrooms and two ware houses.

Objectives of the project:

1. To design the complete electrical installation of a Luxury House which includes the following :

- (i) Illumination Design
- (ii) Lighting Design
- (iii) Power Design
- (iv) Telephone, TV and Data distribution
- (v) Lightning Protection Design

2. To provide all necessary diagrams schedule of materials and costing including labour.

Terms and Conditions:

- 1. Three-phase 415Vrms 50Hz T.T. earthing system
- 2. Z_e : external earth fault loop impedance=0.22 Ω
- 3. C_a : Ambient Temperature 30 degree Celcius
 - 4. General purpose PVC Copper
- 5. Method 3 Cables in Conduit
 - 6. Architectural drawings will be provided
- 7. The IEE Wiring Regulations 16th Edition as currently amended and the local EAC conditions of supply must be complied.
- 8. The illumination design must be in accordance with the CIBS code
- 9. CYTA requirements to be taken into consideration.

Distances shown on the schematic diagram include:

Height of Distribution Boards= 1,6m

Height of Cooker unit= 1,2m

Height of water heater switch= 1,5m

Height of Double pole switch= 0,5m

Height of socket outlet= 0,5m

Height of switches= 1,5m

Height of auxiliary boxes= 0,5m