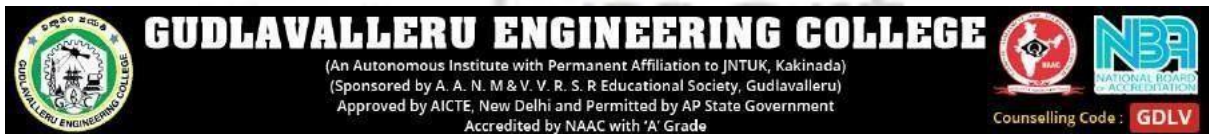


Internship Program Report

By

Pagolu Mahitha -18481A0269



In association with



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Introduction

Internship program arranged by GUDLAVALLERU ENGINEERING COLLEGE in association with Smart Internz, Hyderabad for the benefit of 3rd year EEE batch 2018-2022 on Electrical Detailed design Engineering for Oil& Gas, Power and Utility industrial sectors.

Program organiser

Smart Bridge, Hyderabad.

Pioneer in organising Internships, knowledge workshops, debates, hackathons, Technical



sessions and Industrial Automation projects.

Courtesy

Dr. Sri B. Dasu – HOD – EEE, GEC

Mr. G. Srinivasa Rao – Internship coordinator

Mr. Ramesh V - Mentor

Mr. Vinay Kumar - System Support

Mr. Harikanth – Software/Technical Support

Program details

Smart Internz program schedule: 4 weeks starting from 3rd May 2021

Daily schedule time shall be 4PM to 6.30PM

Mode of Classes: On line through ZOOM

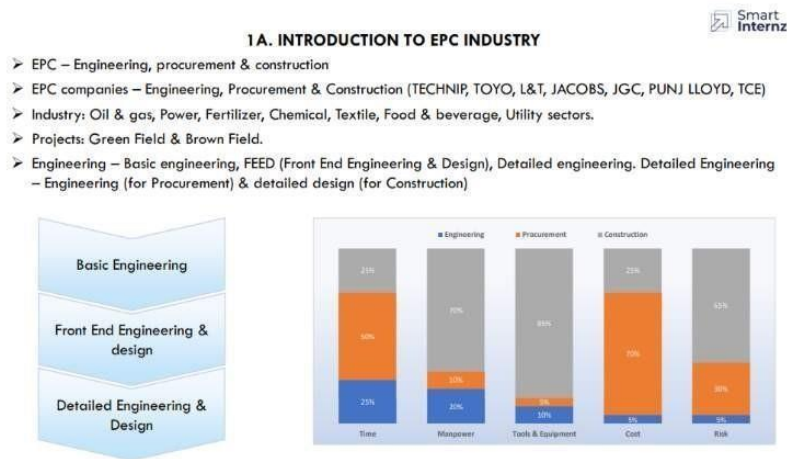
Presenter: Mr Ramesh V

Internship program

We have been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design engineering for various industrial sectors.

3rd May2021: Introduction to EPC Industry

1	EPC Industry & Electrical Detailed Engineering	EPC Industry	Introduction
		Engineering	Types of Engineering
		Procurement	Engineering role in procurement
		Construction	Engineering role during construction



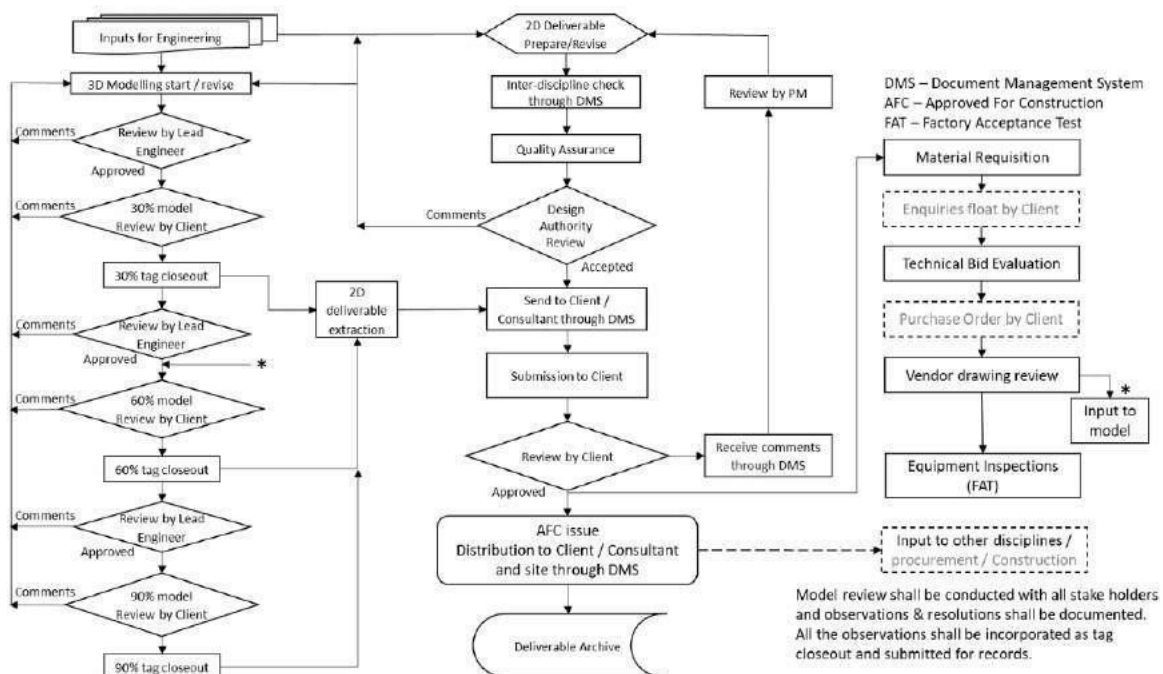
Topic details:

Engineering phases, Engineering deliverables (drawings & documents) list, Design Engineer role at various phases of project.

4th May2021: Engineering documentation for EPC projects

2	Electrical Design Documentation	Engineering Deliverables list	Sequence of deliverables
		Detailed Engineering work flow	Detailed engineering process
		Document transmission	Document submission and info exchange
		Deliverables types	Different types of deliverables

3. ELECTRICAL DESIGN & DETAILED ENGINEERING - PROCESS



Topic details:

Engineering deliverables list, detailed engineering flow, engineering support flow, engineering support to procurements.

5 th May2021: Engineering documentation for commands and formulae

3	Document & Drawing tools	MS Word	Report / Calculations formats
		MS Excel	Basic excel commands
		Autocad	Basic line diagrams and layout commends

3C. AUTOCAD BASIC COMMANDS



AUTOCAD BASIC KEYS							
STANDARD		DRAW		MODIFY		FORMAT	
NEW	Ctrl+N	LINE	L	ERASE	E	PROPERTIES	MO
OPEN	Ctrl+O	RAY	RAY	COPY	CO	SELECT COLOR	COL
SAVE	Ctrl+S	PLINE	PL	MIRROR	MI	LAYER	LA
PLOT	Ctrl+P	3DPOLY	3P	OFFSET	O	LINETYPE	LT
PLOT PREVIEW	PRE	POLIGONE	POL	ARRAY	AR	LINEWEIGHTS	LW
CUT	Ctrl+X	RECTANGLE	REC	MOVE	M	LT SCALE	LTS
COPY	Ctrl+C	ARC	A	ROTATE	RO	LIST	LI
PASTE	Ctrl+V	CIRCLE	C	SCALE	SC	DIMEN. STYLE	D
MATCH PROPE.	MA	SPLINE	SPL	STRECH	S	RENAME	REN
CLOSE	Ctrl+F4	ELLIPSE	EL	TRIM	TR	OPTION	OP
EXIT	Ctrl+Q	BLOCK	B	EXTENED	EX		
		POINT	PO	BRAKE	BR		
		HATCH	H	CHAMFER	CHA		
		GRADIENT	GD	FILLET	F		
		REGION	REG	EXPLODE	X		
		BOUNDARY	BO				
		DONUT	DO				

EXTRA				DRAFTING		PAPER SIZE
UNIT	UN	UCS	UCS	ORTHO	F8, Ctrl+L	A4=210*297
LIMITS	LIMITS	SINGLE TEXT	DT	OSNAP	F3, Ctrl+F	A3=297*420
(0,0;1000,1000)		MULTILINE TEXT	MT	POLAR	F10, Ctrl+U	A2=420*594
ZOOM	Z	EDIT TEXT	ED	GRID	F7, Ctrl+G	A1=594*841
ALL	A	OBJECT SNAP	OB	OTRACK	F11	A0=841*1189
PAN	P	DIMENTION	DIM	SNAP	F9	
CLEAN SCREEN	Ctrl+0	HORIZONTAL	HOR			
COMMAND WIN	Ctrl+9	VERTICAL	VER			



Topic details:

Here we need to learn the basis of the autocadbasic keys like standard, modify, draw, format, papersize etc..

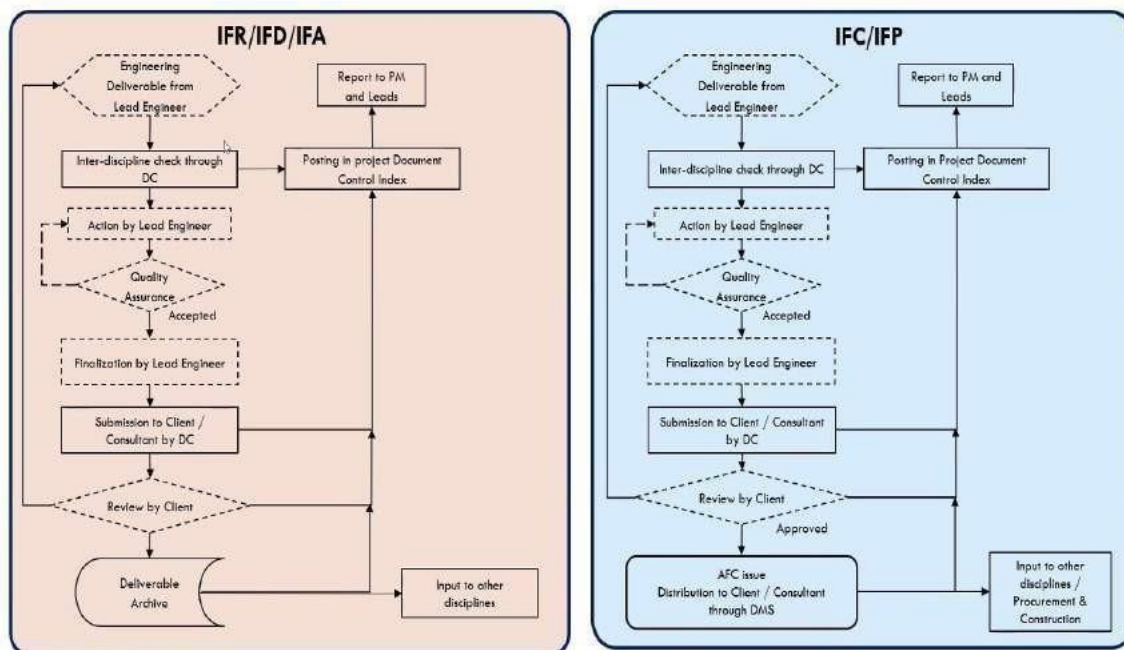
7 th May2021: Engineering documentation for Electrical system design

4	Electrical system design for a small small project	Overall plant description
		Sequence of approach
		Approach to detailed design

Topic details:



1C. DETAILED ENGINEERING



Here we observed that how to do a project and Sequence of approach, Approach to detail design and Overall plant distribution system.

5	Electrical system design for typical diagrams		
		Load lists shedule	Power flow diagram
		Single line diagram	Typical schematic diagram

7

11th May2021: Classification of Transformers and Generators

6	Classification of Transformers and Generators	Different types of Transformers	Different types of Generators
---	---	---------------------------------	-------------------------------

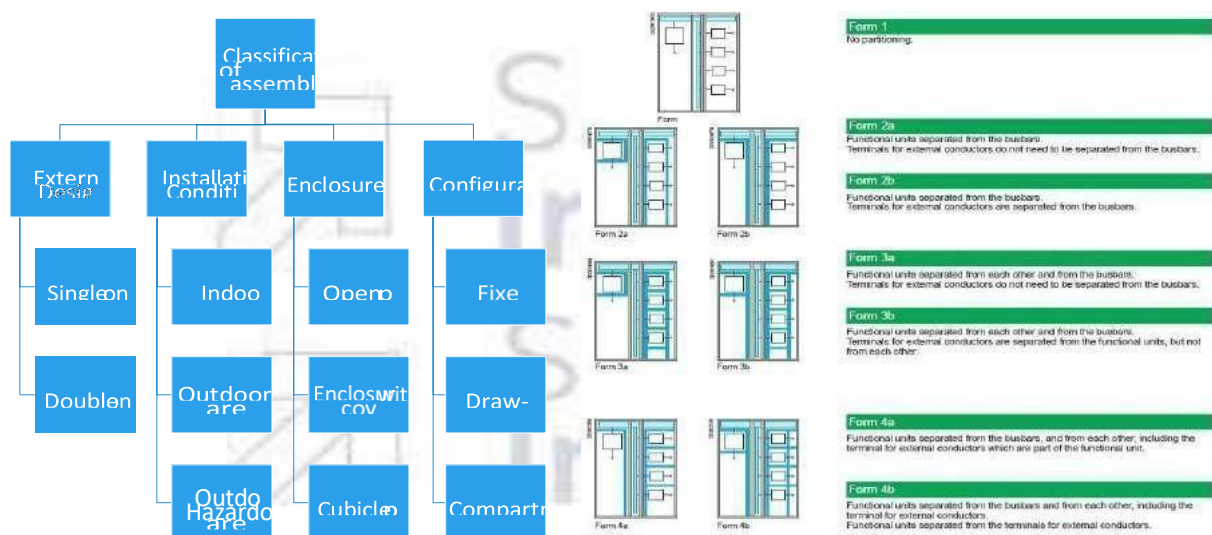


Topic details:

Classification of Transformers and Generators

12th May2021: Classification of Switchgare construction and power factor improvement

7	Classification of Switchgare construction and power factor improvement	Different types of Switchgare assemblies	Power factor improvement

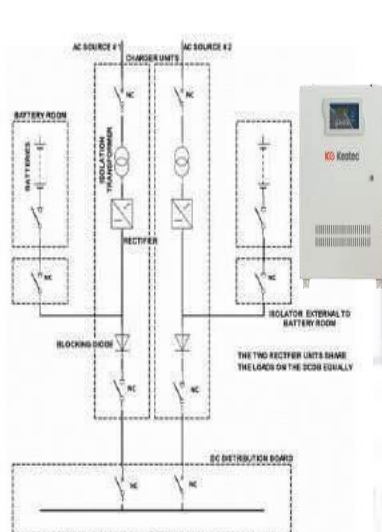


Topic details:

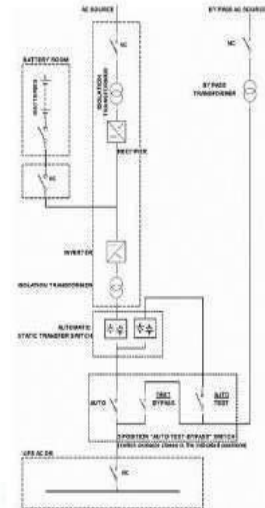
Classification of Switchgare contruction and Power Factor Improvement

17th May2021: Detailing about UPS system and Busducts.

8	Detailing about UPS system and Busducts	Uninterruptible power supply system	Busducts of the system
---	---	-------------------------------------	------------------------



110V or 220V DC
UPS System



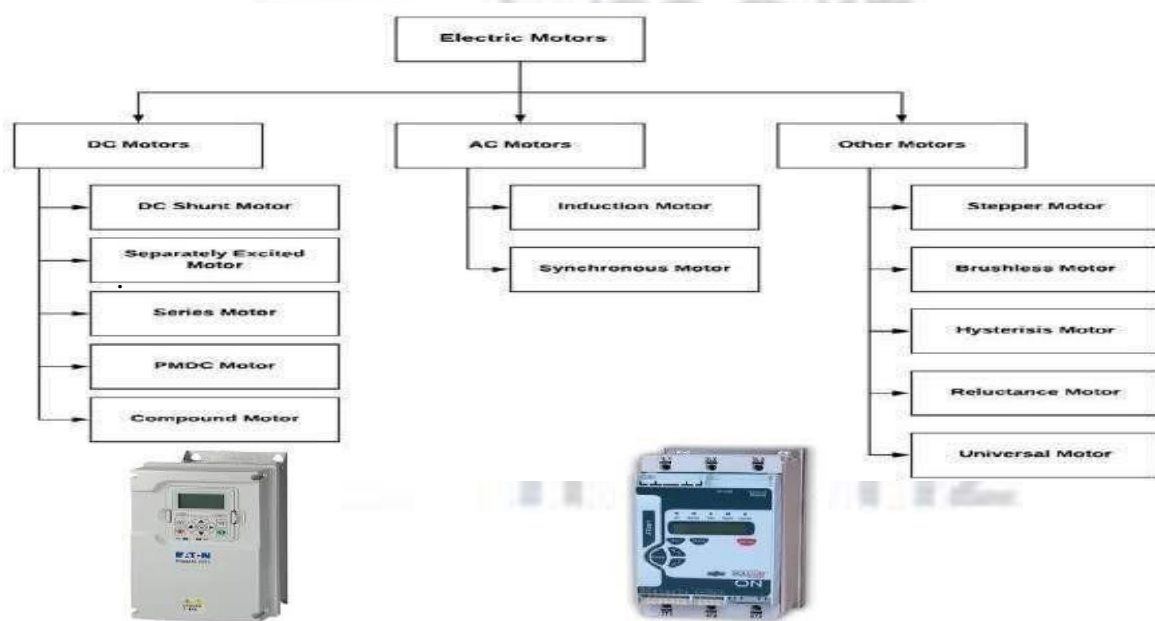
110V or 230V
AC UPS System

Topic details: Power distribution of UPS system and Busducts.

UPS systems are designed to provide continuous power to a load, even with an interruption or loss of utility supply power. UPS generally involves a balance of cost Vs need.

18th May2021: Detailing about MotorStarters and Sizing of motors.

9	Detailing about Motor Starters and Sizing of motors	Motor starters and drives	Sizing and selection of motors
---	---	---------------------------	--------------------------------



Topic details: Detailing about Motor Starter and Sizing of motors and their selection.

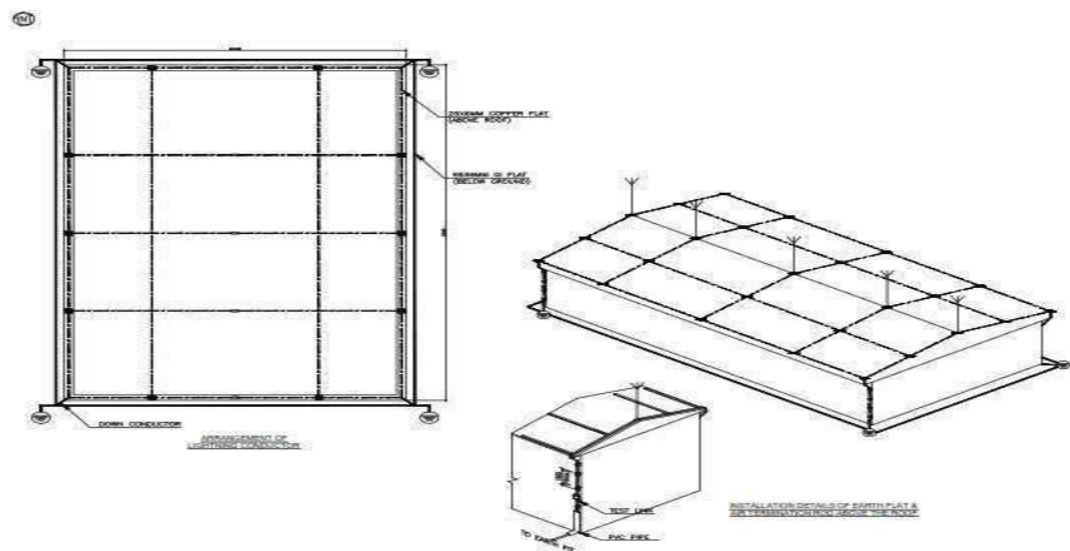
The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is missing in a relay.

Different types of motor starters are as follows:

- Direct-On-Line Starter
- Rotor Resistance Starter
- Stator Resistance Starter
- Auto Transformer Starter

19th May2021: Describing about Earthing system and Lighting Protection.

10	Discribing about Earthing system and Lighting Protection.	Plant Earthing system	Lighting Protection materials
----	---	-----------------------	-------------------------------



Topic details: Describing about Earthing system and Lighting Protection.

Lightning protection required for high rise structures and important buildings against lightning currents during thunder storms. Primarily Lightning protection system calculations are done based on soil resistivity, conductor material, coverage structure / Building to determine whether lightning protection is required or not.

20th May2021: Lighting or illumination systems and calculations.

11	Lighting or Illumination systems and Calculations	Lighting or illumination systems	Lighting calculations
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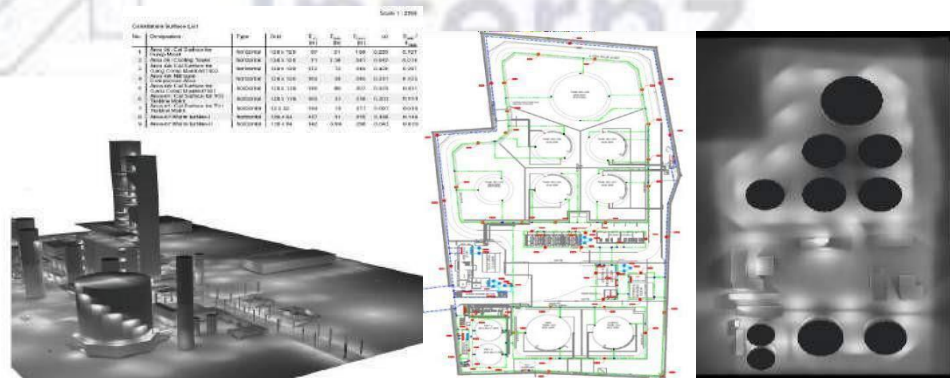
Topic details: Lighting or Illumination systems and Calculations.

All outdoor lighting fittings shall be connected with armoured PVC cable of suitable no. of cores and size. Necessary type and no. of junction boxes shall be provided for branch connections. Indoor light fittings shall be connected with FRLS PVC wires laid in cable trunks or conduits.

Inputs required: Equipment and cable routing layouts, lighting calculations, Design basis for type of light fittings to be used, required lux levels

Lighting calculations software: Dialux, Chalmrite, Calculux, Relux, Luxicon,

CG Lux Applicable Standards: IS 6665: Code of practice for industrial



lighting, IS 3646: Code

of practice for interior illumination, IEC 60598: Luminaires, IEC 62493: Assessment of lighting equipment related to human exposure to electromagnetic field

Deliverables: Indoor Lighting layouts, socket outlet layouts, Street lighting and area lighting layouts. BOQ.

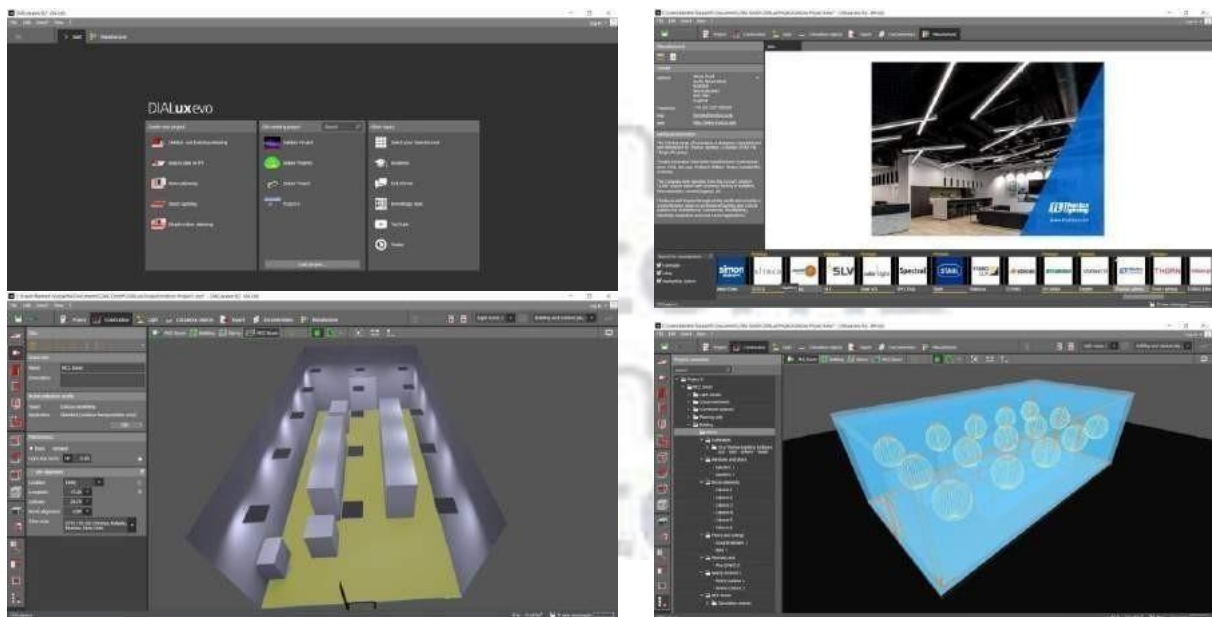
Types of light fittings: Industrial, flame proof type (EX d), increased safety type (Ex e).

21th May2021: Lighting or illumination systems using DIALUX software.

12	Lighting or Illumination using DIALUX software	Lighting or illumination systems	Operation of dialux software
----	--	----------------------------------	------------------------------

Topic details: Lighting or Illumination Calculations using DIALUX software.

Here we are using this Dialux evo 5.9.2 software windows to construct the power plant and we can perform the operation from this software.



24th May2021: Cabling and their calculations and types.

13	Cabling and their types and calculations	Cabling calculations	Types of cabling materials
----	--	----------------------	----------------------------

Topic details: Cabling and their types and calculations .



Electrical cables must be properly supported to relieve mechanical stresses on the conductors, and protected from harsh conditions such as abrasion which might degrade the insulation.

Cables generally laid in the cable trays above ground, direct buried underground and in metallic or PVC conduits. Derating factors may be applicable for each type of cable laying conditions.

25th May2021: Cabling calculations and Cable gland selection.

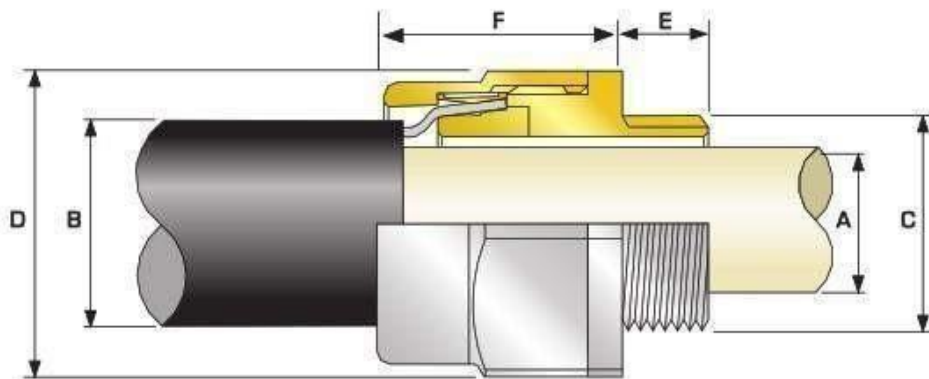
14	Cabling claculations and cable gland selection	Cabling calculations	Cable gland selection
----	--	----------------------	-----------------------

Topic details: Cable sizing calculation and cable gland selection.

Inputs required: Load List, Design basis, Electrical equipment layout, cable schedule, vendor catalogues for cable tray.

Cable tray sizing shall be performed for each branch of cable tray routing up to the load point. Results shall be checked with specified limits mentioned in design basis.

Cable gland:



Cable Gland Selection Table

Refer to illustration at the top of the page.

Cable Gland Size	Available Entry Threads "C" (Alternate Metric Thread Lengths Available)		Cable Bedding Diameter "A"	Overall Cable Diameter "B"	Armour Range		Across Flats "D"	Across Corners "D"	Protrusion Length "F"
	Metric	Thread Length (Metric) "E"	Max	Max	Min	Max	Max	Max	
20S16	M20	10.0	8.7	13.2	0.8	1.25	24.0	26.4	35.2
20S	M20	10.0	11.7	15.9	0.8	1.25	24.0	26.4	32.2
20	M20	10.0	14.0	20.9	0.8	1.25	30.5	33.6	30.6
25	M25	10.0	20.0	26.2	1.25	1.6	36.0	39.6	36.4
32	M32	10.0	26.3	33.9	1.6	2.0	46.0	50.6	32.6
40	M40	15.0	32.2	40.4	1.6	2.0	55.0	60.5	36.6
50S	M50	15.0	38.2	46.7	2.0	2.5	60.0	66.0	39.6
50	M50	15.0	44.1	53.1	2.0	2.5	70.1	77.1	39.1
63S	M63	15.0	50.0	59.4	2.0	2.5	75.0	82.5	52.0
63	M63	15.0	56.0	65.9	2.0	2.5	80.0	88.0	49.8
75S	M75	15.0	62.0	72.1	2.0	2.5	90.0	99.0	63.7
75	M75	15.0	68.0	78.5	2.5	3.0	100.0	110.0	57.3
90	M90	24.0	80.0	90.4	3.15	4.0	114.3	125.7	66.6

15	Load calculations and TR calculations	Load calculations	TR calculations
----	---	-------------------	-----------------

List of electrical load calculations.

[illegible]

17

Calculation for Transformer Capacity**1.0 Example of calculation for Transformer Capacity****1.1 Calculation for consumed load**

Consumed loads used for this example are as follows:

	kW	kVar	kVA	
a. Continuous load	247.5	189.4	311.64	(i)
b. Intermittent load / Diversity Factor	8.37	7.8	11.45	(ii)
c. Stand-by load required as consumed load	74.36	56.5	93.37	(iii)

Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =

257.4

197.4

324.39

Future expansion load (20% capacity)

51.5

39.5

64.88

Total Load =

308.9

236.8

389.27

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load = 324.4 kVA

Spare capacity = 64.9 kVA

Required capacity = 389.3 kVA

Transformer rated capacity = 120 kVA

1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW), while all the other loads running, the voltage regulation is as follows:

 $P_T = 315.1 \text{ KVA}$ ($\%Z = 4$) & Ratio X/R = 3.3Hence, $\%R = 1.176\%$ $\%X = 3.82\%$ $P_M = 55 \text{ KW}$ having ($K = 6$) & $C = 1$ & $\cos \theta = 0.76$ & $\text{Eff.} \eta = 0.88$ & $\cos \theta_s = 0.25$ $P_S = 193.42105 \text{ KVA}$ $\cos \theta_s = 0.25$, Corresponding to Angle $\theta_s = 75.522488$ Degrees for which $\sin \theta_s = 0.97$ $P_B = 324.4 \text{ KVA}$ & P_B in KW is = 275.74 & P_B in Kvar = 197.4 $\therefore \cos \theta_B = 0.850$ $\cos \theta_B = 0.85$, Corresponding to Angle $\theta_s = 31.788331$ Degrees, for which $\sin \theta_s = 0.53$ $P_{CP} = 399.09526 \text{ KW}$ $P_{CQ} = 575.15288 \text{ KVAR}$ $P_C = 784.28849 \text{ KVA}$ $\cos \theta_c = 0.5088628$, where as $\sin \theta_c = 0.861$ Voltage Regulation $\varepsilon = 9.7\%$

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29th May2021: DG set calculations

16	DG set calculations
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Topic details:

Transformer and DG set calculations,types ,sizing or selections

DG SIZING CALCULATIONS		
Design Data		
Rated Voltage	415	KV
Power factor (CosØ)	0.76	Avg
Efficiency	0.88	Avg
Total operating load on DG set in kVA at 0.76 power factor	315.1	
Largest motor to start in the sequence - load in KW	55	KW
Running kVA of last motor (CosØ= 0.91)	82	KVA
Starting current ratio of motor	6	(Considering starting method as Soft starter)
Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	493	KVA
Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	233	KVA
A Continuous operation under load -P1		
Capacity of DG set based on continuous operation under load P1	233	KVA
B Transient Voltage dip during starting of Last motor P2		
Total momentary load in KVA (Starting KVA of the last motor+Base load of DG set in KVA)	726	KVA
Subtransient Reactance of Generator (Xd'')	7.91%	(Assumed)
Transient Reactance of Generator (Xd')	10.065%	(Assumed)
$X_d'' = (X_d'' + X_d') / 2$	0.089875	
Transient Voltage Dip	15%	(Max)
Transient Voltage dip during Soft starter starting of Last motor $P2 = \text{Total momentary load in KVA} \times X_d'' \times \frac{(1 - \text{Transient Voltage Dip})}{(\text{Transient Voltage Dip})}$	370	KVA
C Overload capacity P3		
Capacity of DG set required considering overload capacity		
Total momentary load in KVA	726	KVA
overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
Capacity of DG set required considering overload capacity (P3) = $\frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$	484	KVA
Considering the last value amongst P1, P2 and P3		
Continuous operation under load -P1	233	KVA
Transient Voltage dip during Soft starter starting of Last motor P2	370	KVA
Overload capacity P3	484	KVA
Considering the last value amongst P1, P2 and P3	484	KVA
Hence, Existing Generator 484 KVA is adequate to cater the loads as per re-scheduled loads		
NOTE: VOLTAGE DIP CONSIDERED - 15%		

2nd june2021: Caluculations of Earthing and Lighting protection.

17	Calculation of Earthing and Lighting protection calculations	Earthing calculations	Lighting protection Calculation
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Topic details:

Calculation of Earthing and Lighting protection calculations

Earthing calculation

Maximum line-to-ground fault in kA for 1 sec	10
Earthing material (Earth rod & earth strip)	14
Depth of earth flat burial in meter	GI
Average depth / length of Earth rod in meters	0.5
Soil resistivity Ω-meter	4
Ambient temperature in deg C	17
Plot dimensions (earth grid) L x B in meters	50
Number of earth rods in nos.	65 125
	6
Earth electrode sizing:	
Ac - Required conductor cross section in sq.mm	
$I_{lg} = A_c \times \sqrt{\left[\frac{TCAP \times 10^{-4}}{t_c \times \alpha_r \times \rho_r} \right] \times \left[\frac{K_0 + T_m}{K_0 + T_a} \right]}$	
or - Thermal co-efficient of resistivity, at 20 oC	0.0032
pr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature in °C	50
I _{lg} - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP I/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
KD - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
	14 = Ac *
Ac - Required conductor cross section in sq.mm	0.123
Earth rod dia in mm	114
Earth rod dia (including 25% corrosion allowance) in mm	12
	15
Earth flat sizing:	
Ac - Required conductor cross section in sq.mm	
$I_{lg} = A_c \times \sqrt{\left[\frac{TCAP \times 10^{-4}}{t_c \times \alpha_r \times \rho_r} \right] \times \left[\frac{K_0 + T_m}{K_0 + T_a} \right]}$	
or - Thermal co-efficient of resistivity, at 20 oC	0.0032
pr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature in °C	50
I _{lg} - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP I/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
KD - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	

Lightning calculation

Location	1				
Building	Bellari				
Type of Building	Concrete, School				
Building Length (L)	21				
Building breadth (W)	8				
Building Height (H)	8				
Risk Factor Calculation					
1 Collection Area (A_c)					
A_c		=	$3.14 \times H \times H + 2(H \times L)$		
			536.96		
2 Probability of Being Struck (P)					
P		=	$A_c \times N_s \times 10^{-6}$		
			0.00080544		
3 Overall weighing factor					
a) Use of structure (A)		=	1.7		
b) Type of construction (B)		=	0.4		
c) Contents or consequential effects (C)		=	1.7		
d) Degree of isolation (D)		=	1.0		
e) Type of country (E)		=	0.3		
Wo - Overall weighing factor		=	$A \times B \times C \times D \times E$		
			0.347		
4 Overall Risk Factor					
Po		=	$P \times Wo$		
Po		=	0.000279327		
Pa		=	10^{-5}		
As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor (Po) has been taken as 10^{-5}					
Since Po > Pa lightning protection required.					
5 Air Terminations					
Perimeter of the building		=	$2(L+W)$		
		=	58	Mts.	
6 Down Conductors					
Perimeter of building		=	58	Mts.	
No. of down conductors based on perimeter		=	3	Nos.	
Hence 3 nos. of Down conductors have been selected.					
Size of Down conductor		=	20 X 2.5 mm Galvanized Steel Strip		
(As per BS6651, lightning currents have very short duration, therefore thermal factors are of little consequence in deciding the cross-section of the conductor. The minimum size of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)					

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23

Conclusion

We have been taught many aspects of engineering activities during the EPC stages for all electrical and related other disciplines also.

Feedback

Smart Bridge

They conduct summer internships, work shops, debates, hackthons, technical sessions.

Method of conducting program

Online virtual program with presentation slides and explanation on the topic and practical usage of topic and with some examples.

Program highlights

It is for the detailed design of any industrial sectors.

Material

The material was good .

Benefits

It has been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design engineering for various industrial sectors.

ASSIGNMENT 1

ELECTRICAL LOAD CALCULATIONS LV MCC

[illegible]

Calculation for Transformer Capacity

1.0 Example of calculation for Transformer Capacity

1.1 Calculation for consumed load

Consumed loads used for this example are as follows :

	kW	kVar	kVA	
a. Continuous load	247.5	189.4	311.64	--- (i)
b. Intermittent load / Diversity Factor	8.37	7.8	11.45	--- (ii)
c. Stand-by load required as consumed load	74.36	56.5	93.37	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	257.4	197.4	324.39	
Future expansion load (20% capacity)	51.5	39.5	64.88	
Total Load =	308.9	236.8	389.27	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	324.4 kVA
Spare capacity	=	64.9 kVA
Required capacity	=	389.3 kVA
Transformer rated capacity	=	120 kVA

1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW) , while all the other loads running , the voltage regulation is as follow

$$P_T = 315.1 \text{ KVA} \quad (\%Z) = 4 \quad \& \text{ Ratio X/R} = 3.3$$

$$\text{Hence , } \%R = 1.176 \%$$

$$\%X = 3.82 \%$$

$$P_M = 55 \text{ KW having (K = 6 \& C = 1 \& Cos } \theta = 0.76 \& \text{ Eff. } \eta = 0.88 \& \text{ Cos } \theta_s = 0.25$$

$$P_s = 493.421 \text{ KVA}$$

$$\text{Cos } \theta_s = 0.25 , \text{Corresponding to Angle } \theta_s = 75.5225 \text{ Degrees for which Sin } \theta_s = 0.97$$

$$P_B = 324.4 \text{ KVA} \quad \& \text{ PB in KW is } 275.74 \quad \& \quad P_B \text{ in Kvar} = 197.4 \therefore \text{Cos } \theta_B = 0.850$$

$$\text{Cos } \theta_B = 0.85 , \text{Corresponding to Angle } \theta_s = 31.7883 \text{ Degrees, for which Sin } \theta_s = 0.53$$

$$P_{CP} = 399.095 \text{ KW}$$

$$P_{CQ} = 675.153 \text{ KVAR}$$

$$P_C = 784.288 \text{ KVA}$$

$$\text{Cos } \theta_C = 0.50886 , \text{ where as Sin } \theta_C = 0.861$$

$$\text{Voltage Regulation } \varepsilon = 9.7 \%$$

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx. 5.3% , which meets the criteria to maintain less than 15% voltage regulation.

1.4 Selection of rated capacity

120 kVA transformer selected.

ASSIGNMENT 3

DG SIZING CALCULATIONS		
Design Data		
Rated Volatge	415	KV
Power factor (CosØ)	0.76	Avg
Efficiency	0.88	Avg
Total operating load on DG set in kVA at 0.76 power factor	315.1	
Largest motor to start in the sequence - load in KW	55	KW
Running kVA of last motor (CosØ= 0.91)	82	KVA
Starting current ratio of motor	6	(Considering starting method as Soft starter)
Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	493	KVA
Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	233	KVA
A Continuous operation under load -P1		
Capacity of DG set based on continuous operation under load P1	233	KVA
B Transient Voltage dip during starting of Last motor P2		
Total momentary load in KVA (Starting KVA of the last motor+Base load of DG set in KVA)	726	KVA
Subtransient Reactance of Generator (Xd'')	7.91%	(Assumed)
Transient Reactance of Generator (Xd')	10.065%	(Assumed)
$X_d''' = (X_d'' + X_d')/2$	0.089875	
Transient Voltage Dip	15%	(Max)
Transient Voltage dip during Soft starter starting of Last motor $P2 = \text{Total momentary load in KVA} \times X_d''' \times \frac{(1 - \text{Transient Voltage Dip})}{(\text{Transient Voltage Dip})}$	370	KVA
C Overload capacity P3		
Capacity of DG set required considering overload capacity		
Total momentary load in KVA	726	KVA
overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
Capacity of DG set required considering overload capacity (P3) = $\frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$	484	KVA
Considering the last value amongst P1, P2 and P3		
Continuous operation under load -P1	233	KVA
Transient Voltage dip during Soft starter starting of Last motor P2	370	KVA
Overload capacity P3	484	KVA
Considering the last value amongst P1, P2 and P3	484	KVA
Hence, Existing Generator 484 KVA is adequate to cater the loads as per re-scheduled loads		
NOTE:VOLTAGE DIP CONSIDERED - 15%		

ASSIGNMENT 4 EARTHING CALCULATION

10

Maximum line-to-ground fault in kA for 1 sec	14	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.5	
Average depth / length of Earth rod in meters	4	
Soil resistivity Ω -meter	17	
Ambient temperature in deg C	50	
Plot dimensions (earth grid) L x B in meters	65	125
Number of earth rods in nos.	6	

Earth electrode sizing:

Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c \times \sqrt{\left[\frac{TCAP \times 10^{-4}}{t_c \times \alpha_r \times \rho_r} \right] \times \ln \left[\frac{K_0 + T_m}{K_0 + T_a} \right]}$$

α_r - Thermal co-efficient of resistivity, at 20 Oc	0.0032
ρ_r - Resistivity of ground conductor at 20 Oc	20.10
Ta - Ambient Temperature is °C	50
I _{lg} - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm ³ .oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in Oc	419
K0 - Factor at Oc	293

The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:

14 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	114
Earth rod dia in mm	12
Earth rod dia (including 25% corrosion allowance) in mm	15

Earth flat sizing:

Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c \times \sqrt{\left[\frac{TCAP \times 10^{-4}}{t_c \times \alpha_r \times \rho_r} \right] \times \ln \left[\frac{K_0 + T_m}{K_0 + T_a} \right]}$$

α_r - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρ_r - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
I _{lg} - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1

Thermal capacity factor, TCAP J/(cm ³ .oC)	3.93
T _m - Maximum allowable temperature for copper conductor, in oC	419
K ₀ - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	

**ASSIGNMENT 5
LIGHTNING CALCULATION**

	1
Location	Bellari
Building	Concrete, School
Type of Building	Triangle Roofs (c)
Building Length (L)	21
Building breadth (W)	8
Building Height (H)	8

Risk Factor Calculation

1 Collection Area (A_c)

$$A_c = 3.14 * H * H + 2(H * L) = 536.96$$

2 Probability of Being Struck (P)

$$P = A_c * N_g * 10^{-6} = 0.00080544$$

3 Overall weighing factor

a) Use of structure (A)	=	1.7
b) Type of construction (B)	=	0.4
c) Contents or consequential effects (C)	=	1.7
d) Degree of isolation (D)	=	1.0
e) Type of country (E)	=	0.3
Wo - Overall weighing factor	=	$A * B * C * D * E$
	=	0.347

4 Overall Risk Factor

Po	=	$P * Wo$
Po	=	0.000279327
Pa	=	10^{-5}

As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor (Po) has been taken as 10^{-5}
Since $Po > Pa$ lightning protection required.

5 Air Terminations

Perimeter of the building	=	$2(L+W)$	
	=	58	Mts.

6 Down Conductors

Perimeter of building	=	58	Mts.
No. of down conductors based on perimeter	=	3	Nos.

Hence 3 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Galvanized Ste
(As per BS6651, lightning currents have very short duration, therefore thermal factors are of little consequence in deciding the cross-section of the conductor. The minimum size of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)

CABLE SIZING

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Motor Starting Current (A)	Load P.F. Running	SIN Φ Running	Motor P.F Staring	SIN Φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
3	LV MCC	P 002 3-15	Shower Water Heat pump	50.42	55.00	415	3	87.7	526.10	0.8	0.6	0.8	0.5	2	1	4.0	70	230	0.98	0.9	1	1	0.882	202.9	95	0.3430	0.0752	4.61	1.11	27.01	6.51	OK	29	20
4	LV MCC	FUJ 2 314 -JA	Air conditioning Fan unit (air pump 000)	14.64	15.00	415	3	25.5	152.76	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	1	0.882	75.0	95	1.4700	0.0815	5.13	1.24	30.58	7.37	OK	21	20s
5	LV MCC	FUJ 2 314 -B	Air conditioning Fan unit (air pump 001)	12.60	15.00	415	3	21.9	131.47	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	1	0.882	75.0	60	1.4700	0.0815	2.79	0.67	16.62	4.01	OK	21	20s
6	LV MCC	FUJ 02 3-05	Fridge Pumping Oil gas motor (S)	50.92	55.00	415	3	88.6	531.32	0.8	0.6	0.8	0.5	2	1	4.0	70	230	0.98	0.9	1	1	0.882	202.9	85	0.3430	0.0752	4.17	1.00	24.40	5.88	OK	29	20s
7	LV MCC	MUX 02 R (S)	MUX 02 R (S)	51.31	55.00	415	3	89.2	535.39	0.8	0.6	0.8	0.5	2	1	4.0	70	230	0.98	0.9	1	1	0.882	202.9	75	0.3430	0.0752	3.70	0.89	21.70	5.23	OK	29	20s
8	LV MCC	MUX 02 RB	MUX 02 RB (S)	51.31	55.00	415	3	89.2	535.39	0.8	0.6	0.8	0.5	2	1	4.0	70	230	0.98	0.9	1	1	0.882	202.9	105	0.3430	0.0752	5.19	1.25	30.38	7.32	OK	29	20s
9	LV MCC	BW02 3-1-3	BW02 new r	22.03	30.00	415	3	38.3	229.87	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	100	0.9300	0.0816	5.26	1.27	31.25	7.53	OK	22	20s
10	LV MCC	Road by valve	TN 23 1.3 B (S)	2.14	3.00	415	3	3.7	22.33	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	100	9.4800	0.1007	4.93	1.19	29.53	7.11	OK	16	20s
11	LV MCC	S C2 3-14	S crane control system (S)	4.95	5.00	415	3	8.6	51.65	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	3.59	0.86	21.45	5.17	OK	18	20
12	LV MCC	AGD 23 2-4 A	Q116 air conditioner system (S)	3.71	4.70	415	3	6.5	38.71	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	110	5.9000	0.0947	5.87	1.41	35.16	8.47	OK	17	20s
13	LV MCC	AGD 23 2-4 B	Q116 air conditioner system (S)	3.71	4.70	415	3	6.5	38.71	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	75	5.9000	0.0947	4.00	0.96	23.97	5.78	OK	17	20
14	LV MCC	AGD 2 30-5	Q116 air conditioner system (S)	13.51	15.00	415	3	23.5	140.97	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	1	0.882	75.0	105	1.4700	0.0815	5.23	1.26	31.19	7.52	OK	21	20
15	LV MCC	AGD 2 30-9	Lip oil motor system (S)	4.91	5.50	415	3	8.5	51.23	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	85	3.9400	0.0902	4.03	0.97	24.11	5.81	OK	18	32
16	LV MCC	AGD 2 31-0	Lip oil motor system (S)	4.91	5.50	415	3	8.5	51.23	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	95	3.9400	0.0902	4.50	1.09	26.95	6.49	OK	18	20s
17	LV MCC	AGD 2 31-4	Suspension of fan 17 air fan (S)	8.60	9.20	415	3	15.0	89.74	0.8	0.6	0.8	0.5	2	1	4.0	10	66	0.98	0.9	1	1	0.882	58.2	65	2.3400	0.0852	3.24	0.78	19.34	4.66	OK	18	20s
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1. Overall derating factor $k = k_1 \times k_2 \times k_3 \times k_4$
 - K1=Rating factor for variation in air/ground temperature
 - K2=Rating factor for depth of laying
 - K3=Rating factor for spacing between two circuits
 - K4=Rating factor for variation in thermal resistivity of the soil
2. LT Motors : Running Voltage Drop = 3%, Starting Voltage Drop = 15%
3. Cable type:
 - TYPE 1: Al Conductor, XLPE Insulated, Armoured, PVC outer sheathed
 - TYPE 2: Cu Conductor, XLPE Insulated, Armoured, PVC outer sheathed
4. Effect of Frequency Variation $\pm 5\%$
5. Combined Effect of Voltage & Frequency Variation $\pm 10\%$

ASSIGNMENT 7

CABLE TRAY SIZING

LT CABLES

CABLE TRAY: FROM									
Sr. No.	Cable Route (From-To)	LT-4		TO	LT-5		Self Weight of Cable (Kg/Mt)	Total Weight of Cable (Kg/Mt)	Remarks
		Type & Cable Size	Size of Cable (mm2)		Overall Diameter of each Cable (mm)	Sum of Cable OD (mm)			
1	PMCC-2 TO NEW COOLING W ATER CIRCULATION PUMP- MP-3003A	3C x 185 Sq. mm, XLPE, FRLS AL Cable	185	1	46	46	3.95	3.95	
2	PMCC-2 TO SPACE HEATER FOR NEW COOLING W ATER CIRCULATION PUMP- MP-3003A	2C x 4 Sq. mm, XLPE, FRLS CU Cable	4	1	14	14	0.37	0.37	
3	PMCC-2 TO NEW COOLING W ATER CIRCULATION PUMP- MP-3003B	3C x 185 Sq. mm, XLPE, FRLS AL Cable	185	1	46	46	3.95	3.95	
4	PMCC-2 TO SPACE HEATER FOR NEW COOLING W ATER CIRCULATION PUMP- MP-3003A	2C x 4 Sq. mm, XLPE, FRLS CU Cable	4	1	14	14	0.37	0.37	
5	PMCC-2 TO NEW COOLING W ATER CIRCULATION PUMP- MP-3003C	3C x 185 Sq. mm, XLPE, FRLS AL Cable	185	1	46	46	3.95	3.95	
6	PMCC-2 TO SPACE HEATER FOR NEW COOLING W ATER CIRCULATION PUMP- MP-3003A	2C x 4 Sq. mm, XLPE, FRLS CU Cable	4	1	14	14	0.37	0.37	
7	PMCC-2 TO BLOW DOWN PIT PUMP- MP-3111A	3C x 25 Sq. mm, XLPE, FRLS AL Cable	25	1	22	22	0.9	0.9	
8	PMCC-2 TO BLOW DOWN PIT PUMP- MP-3111B	3C x 25 Sq. mm, XLPE, FRLS AL Cable	25	1	22	22	0.9	0.9	
9	PMCC-2 TO ETP PANEL- MP-3009A	3.5C x 120 Sq. mm, XLPE, FRLS AL Cable	120	1	40	40	2.9	2.9	
10	PMCC-2 TO 110V AC UPS-1	3.5C x 35 Sq. mm, XLPE, FRLS AL Cable	35	1	26	26	1.2	1.2	
11	PMCC-2 TO 110V AC UPS-2	3.5C x 35 Sq. mm, XLPE, FRLS AL Cable	35	1	26	26	1.2	1.2	
12	PMCC-2 TO 110V AC UPS-3	3.5C x 35 Sq. mm, XLPE, FRLS AL Cable	35	1	26	26	1.2	1.2	
13	PMCC-2 TO AUXILIARY PANEL-1	3.5C x 50 Sq. mm, XLPE, FRLS AL Cable	50	1	28	28	1.45	1.45	
14	PMCC-2 TO AUXILIARY PANEL-2(A/C)	3.5C x 70 Sq. mm, XLPE, FRLS AL Cable	70	1	33	33	2	2	
15	PMCC-2 TO COOLING TOWER DOSING SYSTEM PACKAGE	3.5C x 95 Sq. mm, XLPE, FRLS AL Cable	95	1	36	36	2.4	2.4	
16	PMCC-2 TO W ELDING RECEPTACLE-1 & 2	3.5C x 95 Sq. mm, XLPE, FRLS AL Cable	95	1	36	36	2.4	2.4	
17	MLDB TO LDB(COOLING TOWER AREA)	4C x 16 Sq. mm, XLPE, FRLS AL Cable	16	1	21	21	0.85	0.85	
18	MLDB TO LDB(ETP AREA)	4C x 16 Sq. mm, XLPE, FRLS AL Cable	16	1	21	21	0.85	0.85	
19	MLDB TO LDB(DG AREA)	4C x 16 Sq. mm, XLPE, FRLS AL Cable	16	1	21	21	0.85	0.85	
20	MLDB TO LDB(SWITCHYARD)	3.5C x 25 Sq. mm, XLPE, FRLS AL Cable	25	1	23	23	1	1	
21	MLDB TO LDB(CONTROL ROOM)	4C x 16 Sq. mm, XLPE, FRLS AL Cable	16	1	21	21	0.85	0.85	
Total				21		582	33.91	33.91	

Calculation

Maximum Cable Diameter:

Consider Spare Capacity of Cable Tray:

Distance between each Cable:

Calculated Width of Cable Tray:

Calculated Area of Cable Tray:

No of Layer of Cables in Cable Tray:

Selected No of Cable Tray:

Selected Cable Tray Width:

Selected Cable Tray Depth:

Selected Cable Tray Weight Capacity:

Type of Cable Tray:

Total Area of Cable Tray:

46

30%

0

757

34804

1

1

600

100

90

Ladder

60000

mm

mm

Sq.mm

Nos.

mm

mm

Kg/Meter

Sq.mm

Result

Selected Cable Tray width:

Selected Cable Tray Depth:

Selected Cable Tray Weight:

Selected Cable Tray Size:

rease No of Cable Tray or width of C

Required Cable Tray Size:

Required Nos of Cable Tray:

Required Cable Tray Weight:

Type of Cable Tray:

Cable Tray Width Area Remaning

Cable Tray Area Remaning:

Not adequate

O.K

O.K

Not adequate

mm

No

Kg/Meter/Tray

Ladder

-26%

42%

Including Spare Capacity

Including Spare Capacity