

# **Internship Program Report**

**By**

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18481A0209**



**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 3<sup>rd</sup> 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

Dr.G.Srinivasa Rao-Coordinator

Mr. Ramesh V - Mentor

Mr. Vinay Kumar - System Support

Mr. Harikanth – Softwar/Technical Support

### Program details

Smart Internz program schedule: 4 weeks starting from 3<sup>rd</sup> May 2021

Daily schedule time shall be 4PM to 6.30PM

Mode of Classes: Online through ZOOM

Presenter: Mr Ramesh V

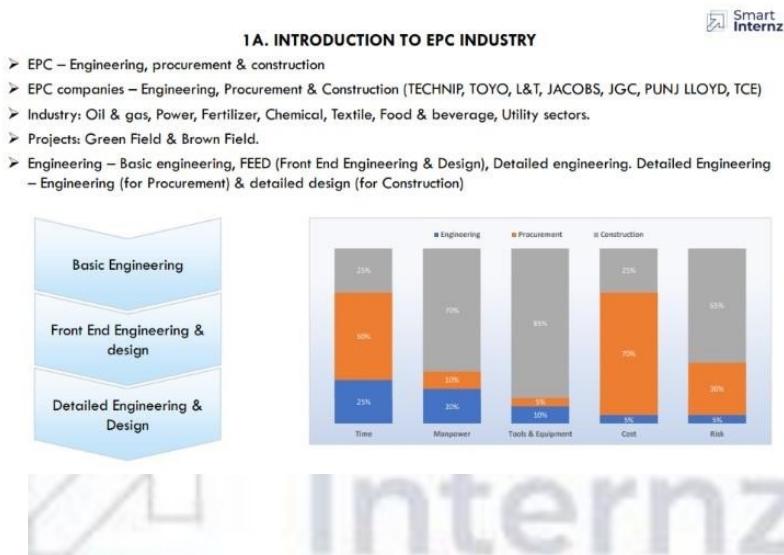
### Internship program

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.

### 3<sup>rd</sup> May2021: Introduction to EPC Industry

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



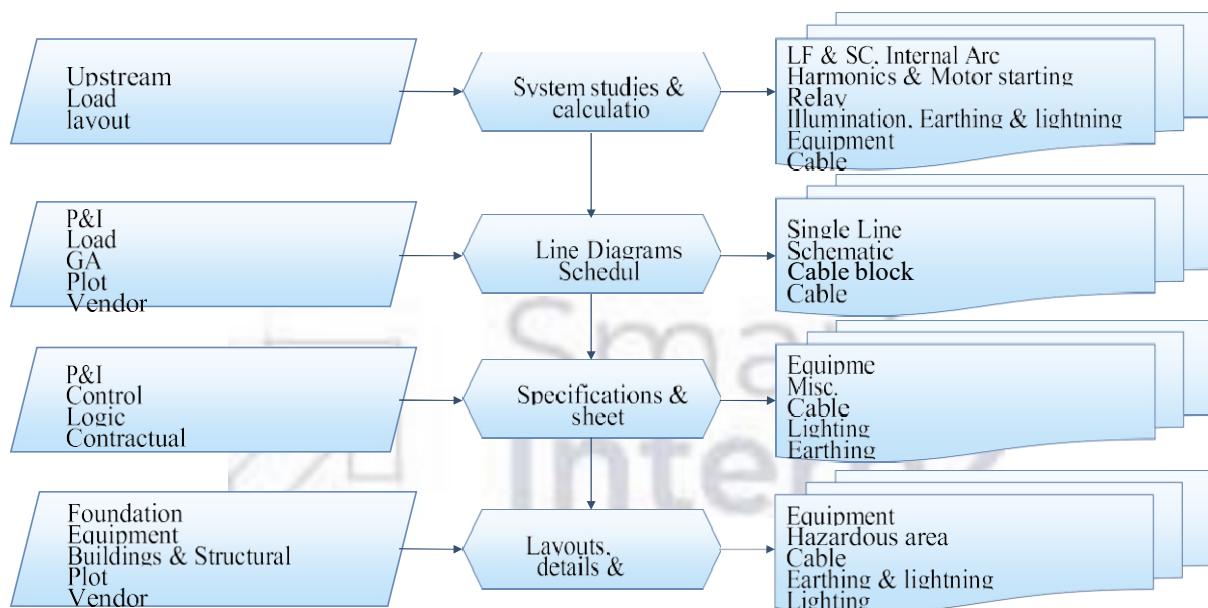
Engineering phases, Engineering deliverables (drawings & documents) list, Design Engineer role at various phases of project.

4<sup>th</sup> May 2021: Engineering documentation for EPC projects

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

### SEQUENCE OF DELIVERABLES



On this day I have learned the Deliverable list of details and work flow in electrical design. And after sequence of deliverables, Detailed engineering process, Document submission and exchange process, and at last I learned about different types of deliverables.

5<sup>th</sup> May 2021: Engineering documentation for commands and formulae

3	Electrical Design Documentation	Ms word commands Ms excel formulae Auto cad basic commands
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Topic details:

MS Word, Excel and Auto cad COMMANDS.

### Word Shortcut Keys

Command Name	Keys
All Caps	Ctrl+Shift+A
Apply List Bullet	Ctrl+Shift+L
Auto Format	Alt+Ctrl+K
Auto Text	F3
Bold	Ctrl+B
Cancel	ESC
Center Para	Ctrl+E
Change Case	Shift+F3
Clear	Del
Close or Exit	Alt+F4
Copy	Ctrl+C
Create Auto Text	Alt+F3
Cut	Ctrl+X
Double Underline	Ctrl+Shift+D
Find	Ctrl+F
Help	F1
Hyperlink	Ctrl+K
Indent	Ctrl+M
Italic	Ctrl+I
Justify Para	Ctrl+J
Merge Field	Alt+Shift+F
New Document	Ctrl+N
Open	Ctrl+O
Outline	Alt+Ctrl+O
Overtype	Insert
Page	Alt+Ctrl+P
Page Break	Ctrl+Return
Paste	Ctrl+V
Paste Format	Ctrl+Shift+V
Print	Ctrl+P
Print Preview	Ctrl+F2
Redo	Alt+Shift+Backspace
Redo or Repeat	Ctrl+Y
Save	Ctrl+S
Select All	Ctrl+A
Small Caps	Ctrl+Shift+K
Style	Ctrl+Shift+S
Subscript	Ctrl+=
Superscript	Ctrl+Shift+=
Task Pane	Ctrl+F1
Time Field	Alt+Shift+T

Underline	Ctrl+U
Undo	Ctrl+Z
Update Fields	F9
Word Count List	Ctrl+Shift+G

Function Keys	
F1	Get Help or visit Microsoft Office Online.
F2	Move text or graphics.
F3	Insert an AutoText (AutoText: A storage location for text or graphics you want to use again, such as a standard contract clause or a long distribution list. Each selection of text or graphics is recorded as an AutoText entry and is assigned a unique name.) entry (after Microsoft Word displays the entry).
F4	Repeat the last action.
F5	Choose the Go To command (Edit menu).
F6	Go to the next pane or frame.
F7	Choose the Spelling command (Tools menu).
F8	Extend a selection.
F9	Update selected fields.
F10	Activate the menu bar.
F11	Go to the next field.
F12	Choose the Save As command (File menu).

Here we need to check the Page setup, spelling, Grammar, Punctuation, Paragraphs, Overall presentations, Tables & pictures to be numbered and titled at last we check the Document name & date of versions.

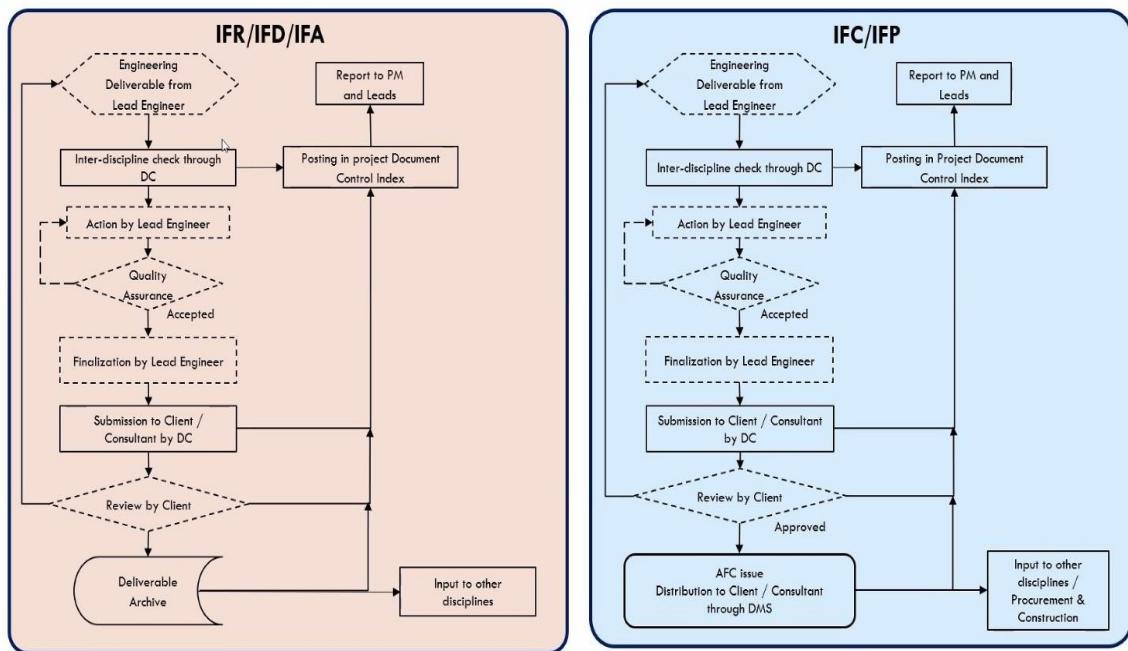
7<sup>th</sup> May 2021: Engineering documentation for Electrical system design

4	Electrical system design for a small small project	Overall plant description Sequence of approach Approach to detailed design
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Topic details: Overall plant description ,approach to detailed design.



### 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.



11<sup>th</sup> May2021: Classification of Transformers and Generators

6	Classification of Transformers and Generators	Different types of Transformers	Different types of Generators
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Topic Details: Classification of Transformers and Generators.



1 Ph. Pad mounted 3 Ph Pole mounted Commercial/ 3 Ph Oil filled (ONAN) Distribution Residential lighting Residential/ street lighting type for industrial & commercial.



415V Diesel generator sets for standby / 240V 1 ph diesel generator set for lighting and & small power only Emergency power supply.

Transformer shall include a primary disconnect on the incoming power source. The disconnect means shall be either a breaker or a load break primary switch that is fused. Transformers are sized to carry the peak running load of all busses connected to them. In addition, feeders to and from power transformers shall be rated to carry full current at the maximum rating.

The packaged combination of a diesel engine, an alternator and various ancillary devices such as base, canopy, sound attenuation, control systems, circuit breakers, jacket water heaters, starting systems etc., is referred to as a Diesel Generating Set or a DG Set in short.

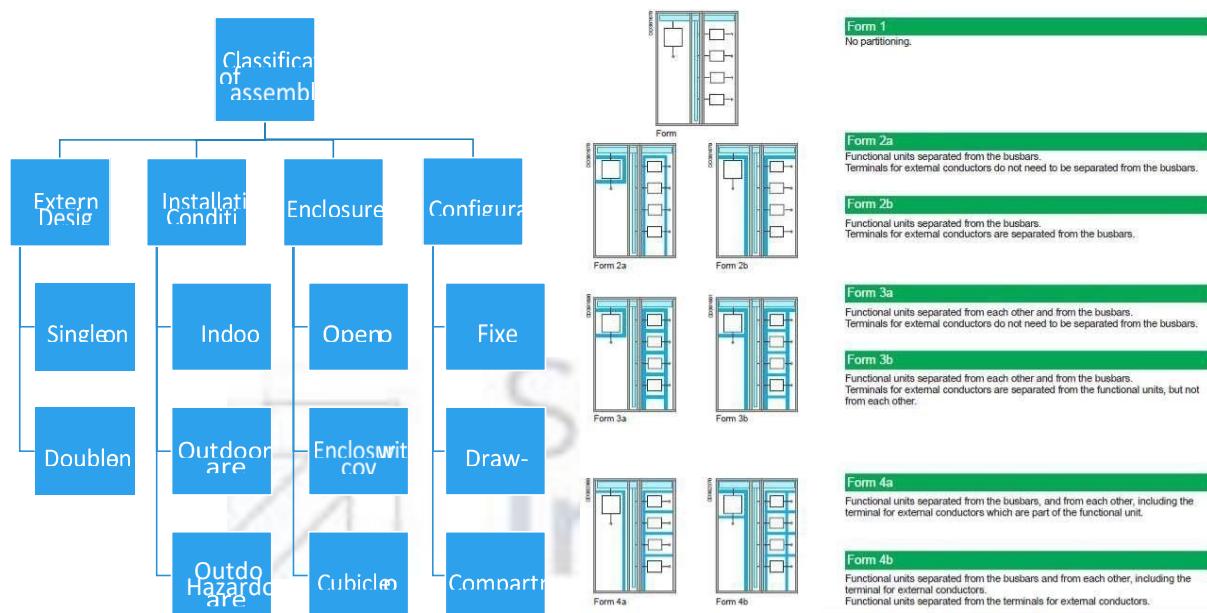
12<sup>th</sup> May 2021: Classification of Switchgare construction and power factor improvement

7      Classification of  
Switchgare  
construction and  
power factor  
improvement

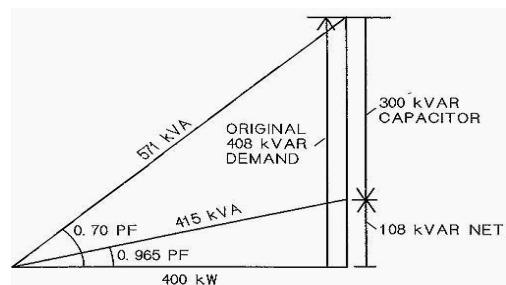
Different types of Switchgare  
assembles

Power factor improvement

Topic details:      Classifiacton of Switchgare contruction and Power Factor Improvement.



Switchgear includes switching & protecting devices like fuses, switches, CTs, VTs, relays, circuit breakers, etc. This device allows operating devices like electrical equipment, generators, distributors, transmission lines, etc.



Power factor defined as the ratio of real power to volt-amperes and is the cosine of the phase angle between the voltage and current in an AC circuit.

17<sup>th</sup> May 2021: Detailing about UPS system and Busducts.

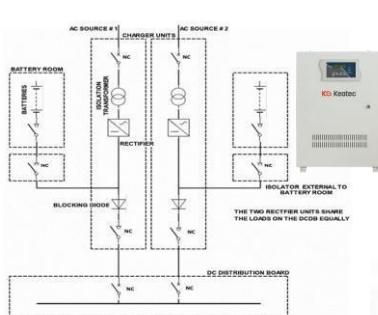
8      Detailing about  
UPS system and  
Busducts

Uninterruptible power supply  
system

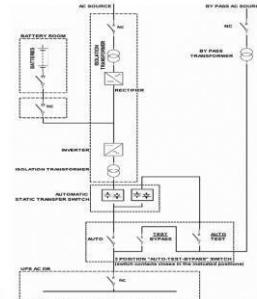
Busducts of the system

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.



110V or 220V DC  
UPS System



110V or 230V  
AC UPS System

Busducts are classified into various types depending on its application viz phase separated Busducts, segregated phase busducts, non-segregated phase busducts.

Phase Separated  
busduct



18<sup>th</sup> May 2021: Detailing about Motor Starters and Sizing of motors.

9      Detailing about  
Motor Starters and  
Sizing of motors

Motor starters and drives

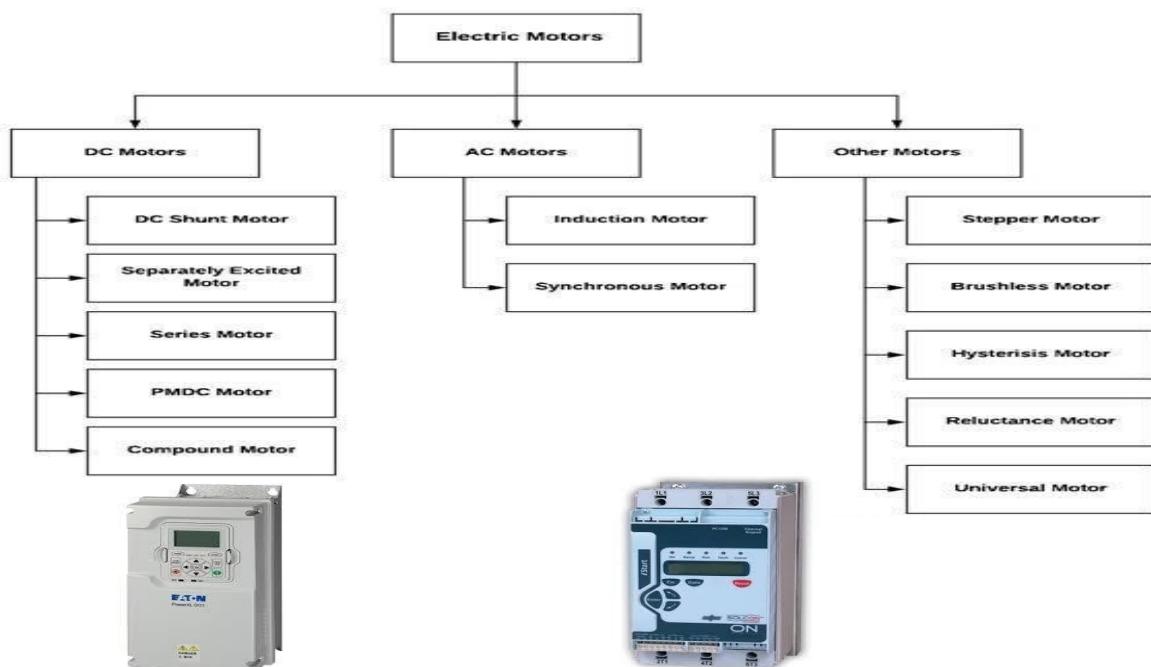
Sizing and selection of motors

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
- Star Delta Starter



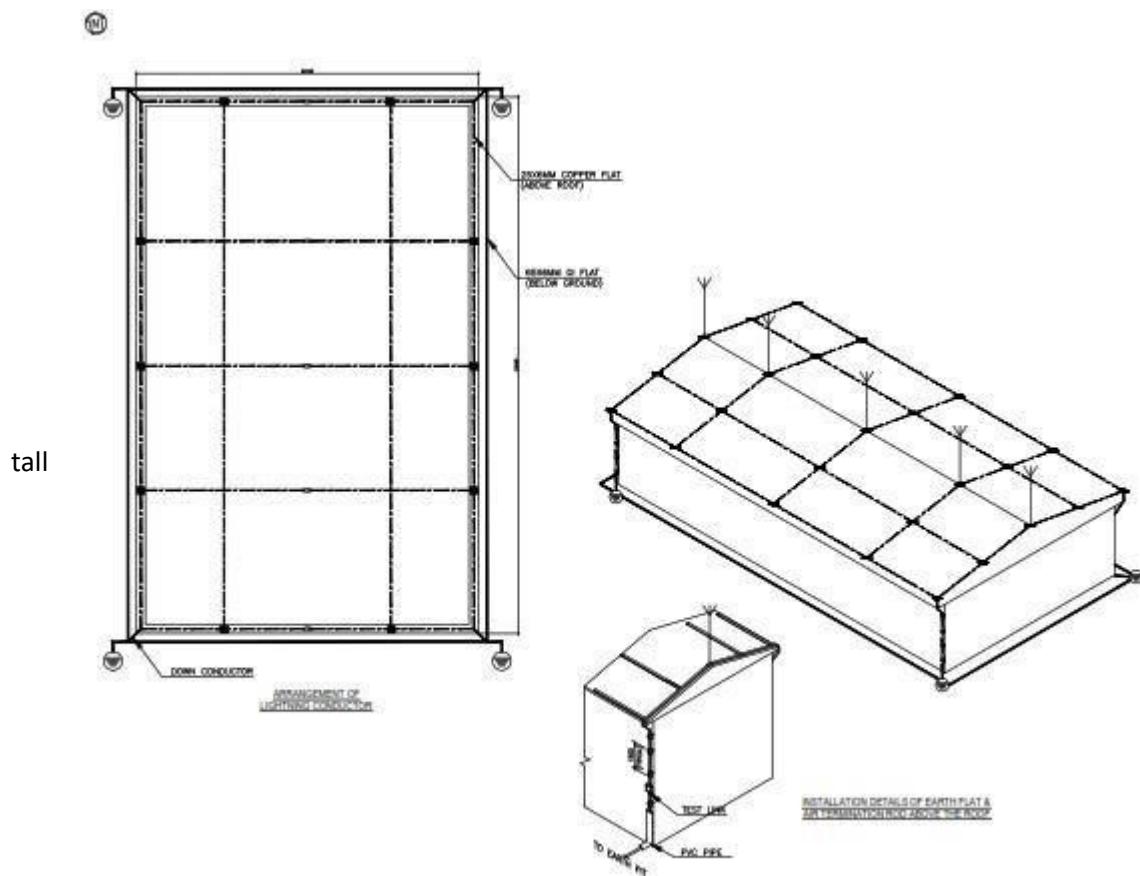
- Starting method – soft starter, Auto transformer, Star/Delta
- Speed variation – Constant speed, variable speed for VFD
  - Frame Size – 56 to 280
- Insulation class & Temp rise – A, E, B, F & H
- Protection – Protection based on voltage & KW rating
- Cable entry, size & termination – Cable sizing based on starting/running voltage drop and short circuit current Vibration – monitoring based on KW rating.

19<sup>th</sup> May2021: Describing about Earthing system and Lighting Protection.

10	Describing about Earthing system and Lighting Protection.	Plant Earthing system	Lighting Protection materials
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Topic details: Describing about Earthing system and Lighting Protection.

The purpose of earthing is to prevent damage to people and prevent or limit plant damage. Various earthing systems are provided with each earthing system is isolated from the other.



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.

20<sup>th</sup> May 2021: Lighting or illumination systems and calculations.

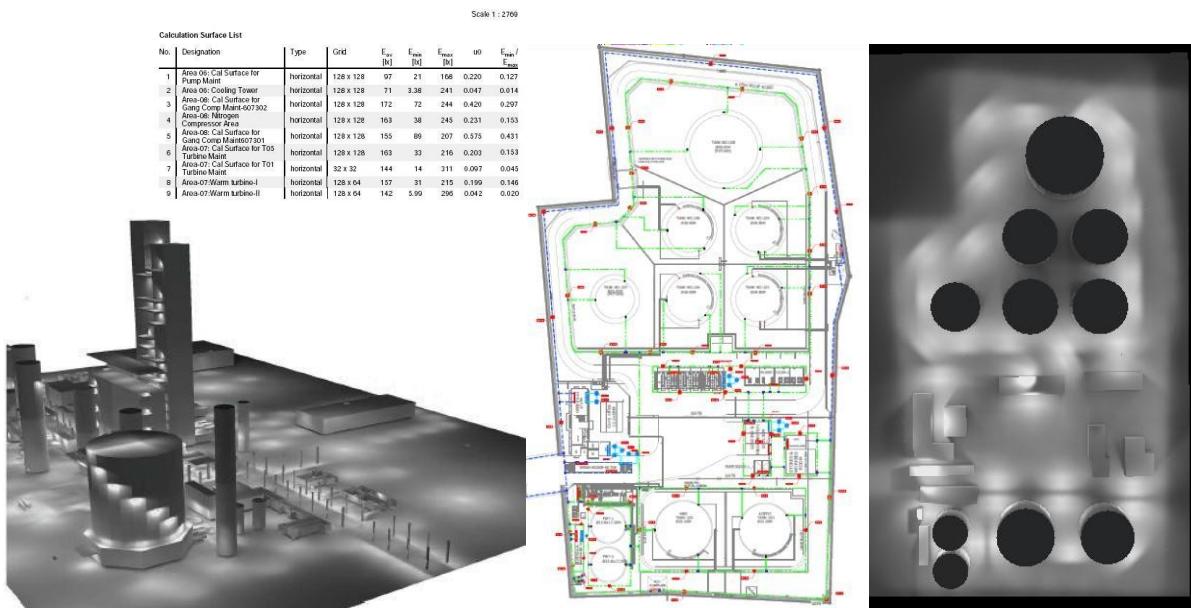
**11      Lighting or  
Illumination  
systems and  
Calculations**

Lighting or illumination systems

Lighting calculations

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, Chalmlite, 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).

21<sup>th</sup> May 2021: Lighting or illumination systems using DIALUX software.

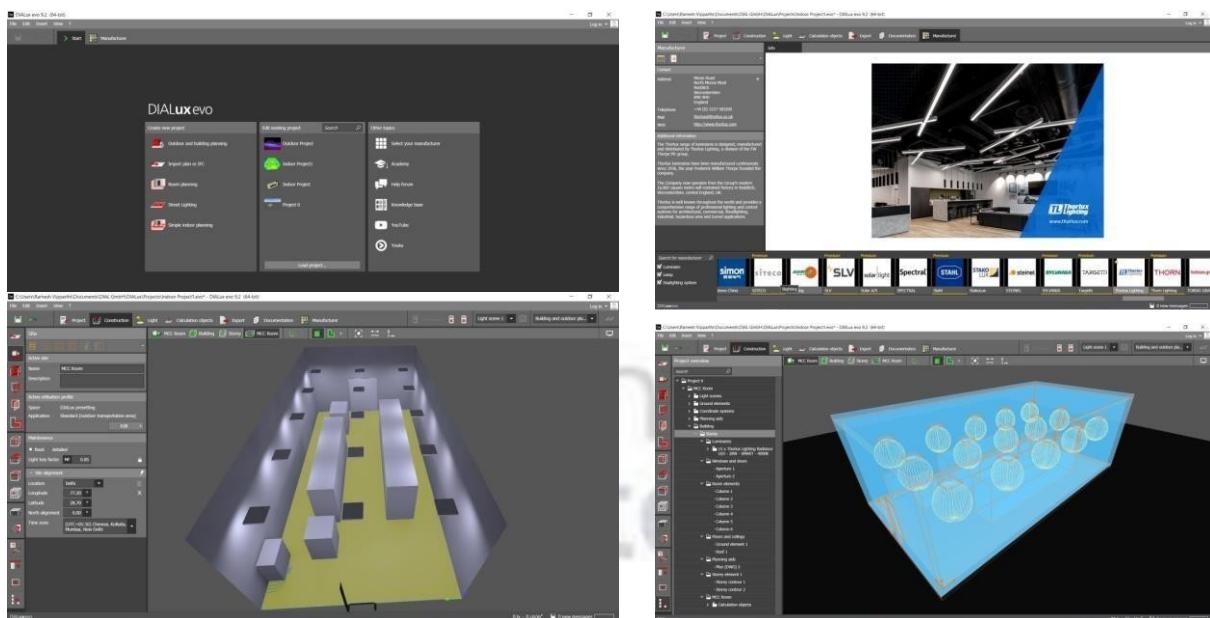
12      Lighting or  
Illumination using  
DIALUX software

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.



We have the indoor calculations and outdoor calculations too.

Results

	Symbol	Calculated	Target	Check	Index
Workplane	$\bar{E}_{\text{perpendicular}}$	264 lx	$\geq 500$ lx	<span style="color:red;">X</span>	<span style="background-color:#e0e0e0;">S2</span>
	$\bar{g}$	0.077	-	-	<span style="background-color:#e0e0e0;">S2</span>
Consumption values	Consumption	1300 kWh/a	max. 3400 kWh/a	<span style="color:green;">✓</span>	
Lighting power density	Room	4.82 W/m <sup>2</sup>	-	-	
		1.83 W/m <sup>2</sup> /100 lx	-	-	

Utilization profile: DIALux presetting, Standard (office)

Luminaire list

pcs.	Manufacturer	Article No.	Article name	P	$\Phi$	Luminous efficacy
15	THORLUX	RAD16401	Radiance LED - 28W - SMART - 4000K	31.0 W	4130 lm	133.2 lm/W

Indoor calculation

Piperack

Luminaire list

$\Phi_{\text{total}}$	P <sub>total</sub>	Luminous efficacy
15850 lm	360.0 W	44.0 lm/W

5	CEAG	122658811 03	122658811 03	72.0 W	3170 lm	44.0 lm/W
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outdoor calculations

24<sup>th</sup> May 2021: 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.

Cable trays shall be generally loaded 60 to 70% leaving space for future use. Underground cabling shall be done in concrete cable trenches with cable trays in paved areas and directly buried with mandatory gap of 300mm between different systems of cables.

25<sup>th</sup> May 2021: Cabling calculations and Cable gland selection.

14 Cabling  
calculations and  
cable gland  
selection

Cabling calculations

Cable gland selection

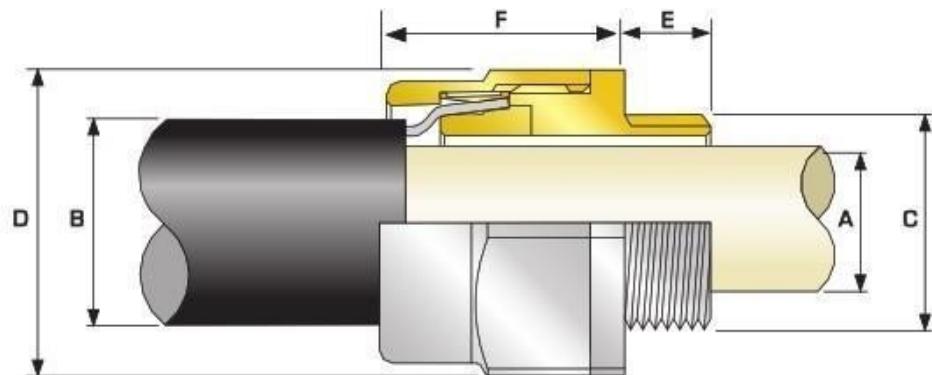
Topic details: Cable sizing calculation and cable gland selection.

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			
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

## 28 th May 2021: Load calculations and Transformer sizing calculations

15    Load calculations  
and TR  
calculations

## Load calculations

## TR calculations

## Topic details:

## List of electrical load calculations.

Sl. No.	Equipment No.	Equipment Description	Rated Power (kW)	Breaker Type	Breaker No. of Poles	ELCB Rating	Absorbed Load (kW)	Motor / Load Rating (kW)	Load Factor (A/I)(B)	Efficiency	Power Factor at Load (C)	Power Factor at Load (C)	kW = (A)(D)	Consumed Load		kVAR = I <sup>2</sup> R + B		
														(A)	(B)	(C)		
mA			kW				decimal		decimal	decimal	decimal	decimal	cost/kWh	kW	kVAR	kW	kVAR	Stand-by
1	PU2315	Silica filter feed pump					12.47	15.00	0.83	0.95	0.73	14.67	13.74					
2	PU2314-A	Absorbent neutral oil pump (W)	3.16				3.16	4.70	0.77	0.95	0.73	3.16	4.3	4.0				
3	PU2316-B	Absorbent neutral oil pump (S)	3.11				3.11	4.70	0.64	0.95	0.73	3.11		3.7	3.4			
4	PU2305	Feed Pump (Separator)					12.58	15.00	0.64	0.95	0.73	14.8	13.9					
5	MX2305	MIXER (W)	12.68				12.68	15.00	0.85	0.95	0.73	14.9	14.0					
6	PU2308	Mixer (S)	12.68				12.68	15.00	0.95	0.95	0.73	14.9	14.0					
7	BV2313	Blower	5.49				7.50	0.73	0.95	0.73	0.73	6.4	6.0					
8	Rotary valve	TK 2313(B)	0.53				0.75	0.71	0.95	0.73	0.73			0.6	0.6			
9	SC2314	Screen cleaner pump (W)	1.23				1.50	0.82	0.95	0.73	0.73			1.45	1.35			
10	SC2316-A	Oil cooler tank agitator (W)	0.31				1.0	0.93	0.95	0.73	0.73	1.07	1.00					
11	AG2324B	Citric acid tank agitator (S)	0.91				1.10	0.83	0.95	0.73	0.73							
12	AG2305	Citric oil reaction vessel agitator	3.34				3.70	0.90	0.95	0.73	0.73	3.93	3.68					
13	AG2310	Lime oil reaction vessel agitator	1.21				1.50	0.81	0.95	0.73	0.73	1.42	1.33					
14	AG2309	Lime oil reaction vessel agitator	1.21				1.50	0.81	0.95	0.73	0.73	1.42	1.33					
15	AG2314	Soap Adsorbant Tank Agitator	2.12				3.00	0.71	0.95	0.73	0.73	2.49	2.34					
Maximum of normal running plant load : (Ext. x%E + y%F)		66.0 kW	61.0 kVAR		$\sqrt{E^2 + F^2} = 90.4 \text{ kVA}$		TOTAL		65.40	61.23	2.07	1.94	19.65	16.39				
Peak Load: (Ext. x%E + y%F + z%G)		68.0 kW	63.7 kVAR		$\sqrt{E^2 + F^2 + G^2} = 93.1 \text{ kVA}$		kVA		89.59		2.64		26.31					
<b>Assumptions</b> a) Load factor, Efficiency and Power factor. b) Load Rating (kWh). c) < 20 & Efficiency = 0.85 & Power factor = 0.91 > 20 & Efficiency = 0.76 & Power factor = 0.91 > 45 & Efficiency = 0.62 & Power factor = 0.91 > 150 & Efficiency = 0.94 & Power factor = 0.91																		

## TR sizing calculations:

## 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	65.4	61.2	89.57	--- (i)
b. Intermittent load / Diversity Factor	2.07	1.9	2.81	--- (ii)
c. Stand-by load required as consumed load	19.65	18.4	26.92	--- (iii)
Max. Consumed load = (i) + 30% (ii) + 10% (iii) =		66.0	61.8	90.42
Future expansion load (20% capacity)		13.2	12.4	18.08
Total Load =		79.2	74.2	108.50

## 1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	90.4 kVA
Spare capacity	=	18.1 kVA
Required capacity	=	108.5 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 :

$$\begin{aligned}
 P_T &= 120 \text{ KVA} & (\%Z) &= 4.19 \quad \& \text{Ratio } X/R &= 3.2 \\
 \text{Hence, } \%R &= & & & = 1.236 \% \\
 \%X &= & & & = 4.00 \% \\
 P_R &= 15 \text{ Kw having ( K = } 6 & C &= 1 & \& \cos \theta_s = 0.73 \& \& \text{Eff.} = 0.85 \& \& \cos \theta_c = 0.25 \\
 P_S &= & & & = 145.04 \text{ KVA} \\
 \text{Cos } \theta_s = 0.25, \text{Corresponding to Angle } \theta_s &= 75.522 \text{ Degrees for which } \sin \theta_s = 0.97 \\
 P_B &= 69.04 \text{ KVA} \quad \& \text{P}_B \text{ in Kvar} &= 58.68 \quad \& \& \cos \theta_B = 0.850 \\
 \text{Cos } \theta_B = 0.85, \text{Corresponding to Angle } \theta_B &= 31.795 \text{ Degrees, for which } \sin \theta_B = 0.53 \\
 P_{CR} &= & & & = 94.941 \text{ KW} \\
 P_{CQ} &= & & & = 176.82 \text{ KVAR} \\
 P_C &= & & & = 200.7 \text{ KVA} \\
 \cos \theta_{CQ} &= 0.4731, \text{ where as } \sin \theta_{CQ} & & & = 0.881 \\
 \text{Voltage Regulation s} &= & & & = 6.9 \% \\
 \end{aligned}$$

**Result** During starting of max. capacity motor, while all other loads are running, the voltage regulation at Transformer secondary terminals is approx. 6.90%

29th May2021: DG set calculations.

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16 DG set  
calculations

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Topic details:

Transformer and DG set calculations, types ,sizing or selections

<b>Design Data</b>		
Rated Voltage	415	KV
Power factor ( $\cos\theta$ )	0.73	Avg
Efficiency	0.85	Avg
Total operating load on DG set in kVA at 0.73 power factor	<b>90.4</b>	
Largest motor to start in the sequence - load in KW	15	KW
Running kVA of last motor ( $\cos\theta=0.91$ )	24	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)	<b>145</b>	KVA
Base load of DG set in KVA (Total operating load in kVA - Running kVA of last motor)	<b>66</b>	KVA
<b>A Continuous operation under load -P1</b> Capacity or DG set based on continuous operation under load P1	<b>66</b>	KVA
<b>B P2</b>		
Total momentary load in KVA (Starting KVA of the last motor+Base load of DG set in KVA)	<b>211</b>	KVA
Subtransient Reactance of Generator ( $X_d''$ )	7.91%	(Assumed)
Transient Reactance of Generator ( $X_d'$ )	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 $P_2 = \text{Total momentary load in KVA} \times X_d''' \times \frac{1}{1-\text{Transient}} \quad (\text{Transient Voltage Dip})$	<b>108</b>	KVA
<b>C Overload capacity P3</b>		
Capacity of DG set required considering overload capacity		
Total momentary load in KVA	<b>211</b>	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) = $\frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$	<b>141</b>	KVA
<b>Considering the last value amongst P1, P2 and P3</b>		
Continuous operation under load -P1	<b>66</b>	KVA
Transient Voltage dip during Soft starter starting of Last motor P2	<b>108</b>	KVA
Overload capacity P3	<b>141</b>	KVA
Considering the last value amongst P1, P2 and P3	<b>141</b>	KVA
Starting	<b>150</b>	KVA

2nd june2021: Calculations 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

Location	2	Bangalore		
Building		Srtuctural, Industrial		
Type of Building		Triangle Roofs (c)		
Building Length (L)	18			
Building breadth (W)	8			
Building Height (H)	6			
<b>Risk Factor Calculation</b>				
<b>Collection Area (A<sub>c</sub>)</b>				
A <sub>c</sub>	=	(3.14 * H * H) + (2 * H * W)		
		209.04		
<b>Probability of Being Struck (P)</b>				
P	=	A <sub>c</sub> * N <sub>g</sub> * 10 <sup>-6</sup>		
		0.000585312		
<b>Overall weighing factor</b>				
a) Use of structure (A)	=	1.0		
b) Type of construction (B)	=	0.8		
c) Contents or consequential effects (C)	=	0.8		
d) Degree of isolation (D)	=	1.0		
e) Type of country (E)	=	0.3		
Wo - Overall weighing factor	=	A * B * C * D * E		
		0.192		
<b>Overall Risk Factor</b>				
P <sub>o</sub>	=	P * Wo		
P <sub>o</sub>	=	0.00011238		
P <sub>a</sub>	=	10 <sup>-5</sup>		

As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor ( P<sub>o</sub> ) has been taken as 10<sup>-5</sup>. Since P<sub>o</sub> > P<sub>a</sub> lightning protection required.

Earthing calculations:

Maximum line-to-ground fault in kA for 1 sec	2		
Earthing material (Earth rod & earth strip)	14		
Depth of earth flat burrial in meter	GI		
Average depth / length of Earth rod in meters	0.5		
Soil resistivity Ω-meter	4.5		
Ambient temperature in deg C	13		
Plot dimensions (earth grid) L x B in meters	55		
Number of earth rods in nos.	75	135	
	6		

**Earth electrode sizing:**

Ac - Required conductor cross section in sq.mm

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	55
I <sub>lg</sub> - RMS fault current in kA = 50 KA	14
t <sub>c</sub> - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm <sup>3</sup> .oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
K0 - Factor at oC	293



## 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, hackathons, 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**

Sl. No.	Equipment No.	Equipment Description	Breaker Rating A	Breaker Type	Breaker No. of Poles	ELCB Rating mA	Absorbed Load [A]	Motor / Load Rating [B]	Load Factor [A] / [B] [C]	Eff ciency at Load Fa tor [C] [D]	Power Factor at Load Factor [C]	kW = [A] / [D]		Consumed Load		kVAR = kW x tan φ		Remarks		
												kW	decimal	cos φ	kW	kVAR	kW	kVAR		
1	PU2315	Silica filter feed pump										12.47	15.00	0.83	0.85	0.73	14.6	13.7		
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)										3.62	4.70	0.77	0.85	0.73	4.3	4.0		
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)										3.11	3.70	0.84	0.85	0.73			3.1 3.1	
4	PU2305	Feed Pump (Seperator)										12.58	15.00	0.84	0.85	0.73	14.8	13.9		
5	MX2305	MIXER (W)										12.68	15.00	0.85	0.85	0.73	14.9	14.0		
6	MX 2308	MIXER (S)										12.68	15.00	0.85	0.85	0.73			14.9 14.9	
7	BW2313	Blower										5.45	7.50	0.73	0.85	0.73	6.4	6.0		
8	Rotary valve	TK 2313B (I)										0.53	0.75	0.71	0.85	0.73			0.0 0.0	
9	SC2314	Screw conveyor (I)										1.23	1.50	0.82	0.85	0.73			1.45 1.35	
10	AG 2324A	Citric acid tan agitator (W)										0.91	1.10	0.83	0.85	0.73	1.01	1.00		
11	AG 2324B	Citric acid tank agitator (S)										0.91	1.10	0.83	0.85	0.73			1.1 1.1	
12	AG 2305	Citric oil rection vessol agitator										3.34	3.70	0.90	0.85	0.73	3.93	3.68		
13	AG 2309	Lye oil reaction vessel agitator										1.21	1.50	0.81	0.85	0.73	1.42	1.33		
14	AG 2310	Lye oil reaction vessel agitator										1.21	1.50	0.81	0.85	0.73	1.42	1.33		
15	AG 2314	Soap Adsorbant Tank Agitator										2.12	3.00	0.71	0.85	0.73	2.49	2.34		
Maximum of normal running plant load : (Est. x%E + y%F)		66.0 kW					61.8 kVAR					sqrt (kW <sup>2</sup> +kVAR <sup>2</sup> ) =	90.4 kVA		TOTAL	65.40	61.23	2.0	1.94	19.6 18.38
Peak Load : (Est. x%E + y%F + z%G)		68.0 kW					63.7 kVAR					sqrt (kW <sup>2</sup> +kVAR <sup>2</sup> ) =	93.1 kVA		kVA	89.59	2.84		26.91	
<b>Assumptions</b>																				
1) Load factor, Efficiency and Power factor.																				
Load Rating (kW)																				
<= 20																				
0.85																				
> 20 - <= 45																				
0.91																				
> 45 - < 150																				
0.93																				
>= 150																				
0.94																				
2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for continuos, intermittent and standby load.																				

## **Assignment-2**

### **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 :

	<b>kW</b>	<b>kVar</b>	<b>kVA</b>	
a. Continuous load	65.4	61.2	89.57	--- (i)
b. Intermittent load / Diversity Factor	2.07	1.9	2.81	--- (ii)
c. Stand-by load required as consumed load	19.65	18.4	26.92	--- (iii)

$$\begin{aligned} \text{Max. Consumed load} &= ((\text{i}) + 30\% (\text{ii}) + 10\% (\text{iii})) = & 66.0 \\ \text{Future expansion load (20\% capacity)} &= & 13.2 \\ \text{Total Load} &= & 79.2 \end{aligned}$$

$$\begin{aligned} & 61.8 \\ & 12.4 \\ & 74.2 \end{aligned}$$

$$\begin{aligned} & 90.42 \\ & 18.08 \\ & 108.50 \end{aligned}$$

#### **1.2 Calculation for 3.3kV / 0.433 kV transformer capacity**

$$\begin{aligned} \text{Max. Consumed load} &= 90.4 \text{ kVA} \\ \text{Spare capacity} &= 18.1 \text{ kVA} \\ \text{Required capacity} &= 108.5 \text{ kVA} \\ \text{Transformer rated capacity} &= 120 \text{ kVA} \end{aligned}$$

#### **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 :

$$P_T = 120 \text{ KVA} \quad (\%) = 4.19 \quad \text{& Ratio X/R} = 3.2$$

$$\text{Hence, \%R} = 1.236 \%$$

$$\%X = 4.00 \%$$

$$\begin{aligned} P_M &= 15 \text{ KW having } (K = 6) \quad \& C = 1 \quad \& \cos \theta = 0.73 \quad \& \text{Eff.h} = 0.85 \quad \& \cos Q_s = 0.25 \\ P_S &= = 145.044 \text{ KVA} \end{aligned}$$

$$\begin{aligned} \cos \theta_s &= 0.25, \text{ Corresponding to Angle } \theta_s = 75.5225 \text{ Degrees for which } \sin \theta_s = 0.97 \\ P_B &= 69.04 \text{ KVA} \quad \& P_B \text{ in KW} = 58.68 \quad \& \cos \theta_B = 0.850 \\ \cos \theta_B &= 0.85, \text{ Corresponding to Angle } \theta_B = 31.7946 \text{ Degrees, for which } \sin \theta_B = 0.53 \end{aligned}$$

$$\begin{aligned} P_{CP} &= 94.9411 \text{ KW} \\ P_{CQ} &= 176.819 \text{ KVAR} \\ P_C &= 200.695 \text{ KVA} \end{aligned}$$

$$\cos \theta_C = 0.47306, \text{ where as } \sin \theta_C = 0.881$$

$$\text{Voltage Regulation e} = 6.9 \%$$

**Result:** During starting of max. capacity motor, while all other loads are running, the voltage regulation at Transformer secondary terminals is approx 6.90%

#### **1.4 Selection of rated capacity**

120 kVA transformer selected.

Assignment-3		
DG SIZING CALCULATIONS		
<b>Design Data</b>		
Rated Volatge	415	KV
Power factor ( $\cos\phi$ )	0.73	Avg
Efficiency	0.85	Avg
Total operating load on DG set in kVA at 0.73 power factor	90.4	
Largest motor to start in the sequence - load in KW	15	KW
Running kVA of last motor ( $\cos\phi = 0.91$ )	24	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)	145	KVA
Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	66	KVA
<b>A Continous operation under load -P1</b>		
Capacity of DG set based on continuous operation under load P1	66	KVA
<b>B Transient Voltage dip during starting of Last motor P2</b>		
Total momentary load in KVA (Starting KVA of the last motor+Base load of DG set in KVA)	211	KVA
Subtransient Reactance of Generator ( $X_d''$ )	7.91%	(Assumed)
Transient Reactance of Generator ( $X_d'$ )	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 $P_2 = \text{Total momentary load in KVA} \times X_d''' \times \frac{(1-\text{Transient Voltage Dip})}{(\text{Transient Voltage Dip})}$	108	KVA
<b>C Overload capacity P3</b>		
Capacity of DG set required considering overload capacity		
Total momentary load in KVA	211	KVA
overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
Capacity of DG set required considering overload capacity $(P_3) = \frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$	141	KVA
<b>Considering the last value amongst P1, P2 and P3</b>		
Continous operation under load -P1	66	KVA
Transient Voltage dip during Soft starter starting of Last motor P2	108	KVA
Overload capacity P3	141	KVA
Considering the last value amongst P1, P2 and P3	141	KVA
starting capacity	150	KVA
Hence,DG set is 150 KVA is adequate and catch		
NOTE: VOLTAGE DIP CONSIDERED - 15%		

## Assignment-4

### Earthing calculations

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	4.5
Soil resistivity $\Omega$ -meter	13
Ambient temperature in deg C	55
Plot dimensions (earth grid) L x B in meters	75      135
Number of earth rods in nos.	6

Earth electrode sizing:

Ac - Required conductor cross section in sq.mm

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

$\alpha_r$ - Thermal co-efficient of resistivity, at 20 oC	0.0032
$\rho_r$ - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	55
$I_{lg}$ - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm <sup>3</sup> .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

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

$\alpha_r$ - Thermal co-efficient of resistivity, at 20 oC	0.0032
$\rho_r$ - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	55
$I_{lg}$ - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm <sup>3</sup> .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 flat area in mm	12
Earth flat area (including 25% corrosion allowance) in mm	15
Selected flat size W * Thk in sq mm	20

*R<sub>g</sub>* - Grid resistance

Grid resistance can be calculated using Eq. 52 of IEEE 80

$$R_g = \rho \left[ \frac{1}{L} + \frac{1}{\sqrt{20 \times A}} \right] + \frac{1}{1 + h \sqrt{20 / A}}$$

*ρ* - Soil resistivity in Ω-meter=

13

*L* - Total buried length of ground conductor in meter

420

*h* - Depth of burial in meter

0.5

*A* - Grid area in sq. meter

10125

*R<sub>g</sub>* - Grid resistance      0.088

*R<sub>r</sub>* - Earth Electrode resistance

Grid resistance can be calculated using Eq. 55 of IEEE 80

$$R_r = \frac{\rho}{r} \left[ 1 + \frac{4 \times L_r}{n} \right] \left[ 1 + \frac{2 \times k_1 \times L_r}{\sqrt{A}} \left( \sqrt{n_r} - 1 \right)^2 \right]$$

*ρ* - Soil resistivity in Ω-meter, 16.96

13

*n* - No of earth electrodes

6

*L<sub>r</sub>* - Length of earth electrode in meter

4.5

*b* - Diameter of earth electrode in meter

0.020

*k<sub>1</sub>* - co-efficient

1

*A* - Area of grid in square metre

10125

*R<sub>r</sub>* - Earth Electrode resistance      4.7747

Grounding system resistance

Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:

$$R_s = \frac{R_g \times R_2 \times R_m^2}{R_g + R_2 - 2R_m}$$

*R<sub>m</sub>* - Mutual ground resistance between the group of ground conductors, *R<sub>g</sub>* and group of electrodes, *R<sub>r</sub>* in Ω. Neglected *R<sub>m</sub>*, since this is for homogenous soil

*R<sub>s</sub>* - Total earthing system resistance      0.087 Ohms

The calculated resistance grounding system is less than the allowable 1 Ω value.

## Assignment-5

### Lighting Protection Calculations

Location	Bangalore
Building	Srtuctural, Industrial
Type of Building	Triangle Roofs (c)
Building Length (L)	18
Building breadth (W)	8
Building Height (H)	6

#### **Risk Factor Calculation**

##### **1 Collection Area ( $A_c$ )**

$$A_c = \frac{(3.14 * H * H) + (2 * H * W)}{209.04}$$

##### **2 Probability of Being Struck (P)**

$$P = \frac{A_c * N_g * 10^{-6}}{0.000585312}$$

##### **3 Overall weighing factor**

a) Use of structure (A)	=	1.0
b) Type of construction (B)	=	0.8
c) Contents or consequential effects (C)	=	0.8
d) Degree of isolation (D)	=	1.0
e) Type of country (E)	=	0.3
Wo - Overall weighing factor	=	$A * B * C * D * E$
	=	0.192

##### **4 Overall Risk Factor**

$$\begin{aligned} P_o &= P * Wo \\ P_o &= 0.00011238 \\ P_a &= 10^{-5} \end{aligned}$$

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

#### **5 Air Terminations**

$$\begin{aligned} \text{Perimeter of the building} &= 2(L+W) \\ &= 52 \quad \text{Mts.} \end{aligned}$$

#### **6 Down Conductors**

$$\begin{aligned} \text{Perimeter of building} &= 52 \quad \text{Mts.} \\ \text{No. of down conductors based on perimeter} &= 3 \quad \text{Nos.} \end{aligned}$$

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)



## Cable Tray Sizing calculations

CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No.	Cable Route (From-To)	Type & Cable Size	Size of Cable (mm <sup>2</sup> )	No. of Cable	Overall Diameter of each Cable (mm)	Sum of Cable OD (mm)	Self Weight of Cable (Kg/Mt)	Total Weight of Cable (Kg/Mt)	Remarks
1	LV MCC	4	10	1	18	18	3.95	0.9	
2	PU2315-VFD	4	10	1	18	18	0.37	0.9	
3	PU2315-VFD	5	1.5	1	15	15	3.95	0.4	
4	LV MCC	4	2.5	1	16	16	0.37	0.5	
5	LV MCC	5	1.5	1	15	15	3.95	0.4	
6	LV MCC	4	2.5	1	16	16	0.37	0.5	
7	PU 2314-B-VFD	4	2.5	1	16	16	0.9	0.5	
8	PU 2314-B-VFD	5	1.5	1	15	15	0.9	0.4	
9	LV MCC	4	6	1	18	18	2.9	0.7	
10	PU2305-VFD	4	6	1	18	18	1.2	0.7	
11	PU2305-VFD	5	1.5	1	15	15	1.2	0.4	
12	LV MCC	4	6	1	18	18	1.2	0.7	
13	LV MCC	5	1.5	1	15	15	1.45	0.4	
14	LV MCC	4	10	1	18	18	2	0.9	
15	LV MCC	5	1.5	1	15	15	2.4	0.4	
16	LV MCC	4	6	1	18	18	2.4	0.7	
17	BW2313-VFD	4	6	1	18	18	0.85	0.7	
18	BW2313-VFD	5	1.5	1	15	15	0.85	0.4	
19	LV MCC	4	6	1	18	18	0.85	0.7	
20	LV MCC	5	1.5	1	15	15	1	0.4	
21	LV MCC	4	6	1	18	18	0.85	0.7	
Total				21			348	33.91	12.3