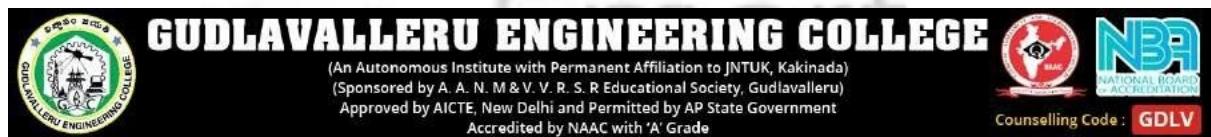


Internship Program Report

By

KUSAM TEJA SRI-18481A0256



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.

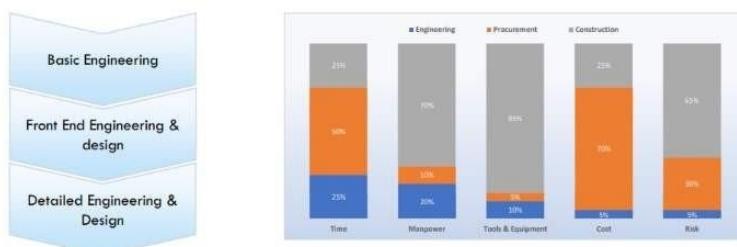
3rd May2021: Introduction to EPC Industry

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

1A. INTRODUCTION TO EPC INDUSTRY



- EPC – Engineering, procurement & construction
- EPC companies – Engineering, Procurement & Construction (TECHNIP, TOYO, L&T, JACOBS, JGC, PUNJ LLOYD, TCE)
- Industry: Oil & gas, Power, Fertilizer, Chemical, Textile, Food & beverage, Utility sectors.
- Projects: Green Field & Brown Field.
- Engineering – Basic engineering, FEED (Front End Engineering & Design), Detailed engineering. Detailed Engineering – Engineering (for Procurement) & detailed design (for Construction)



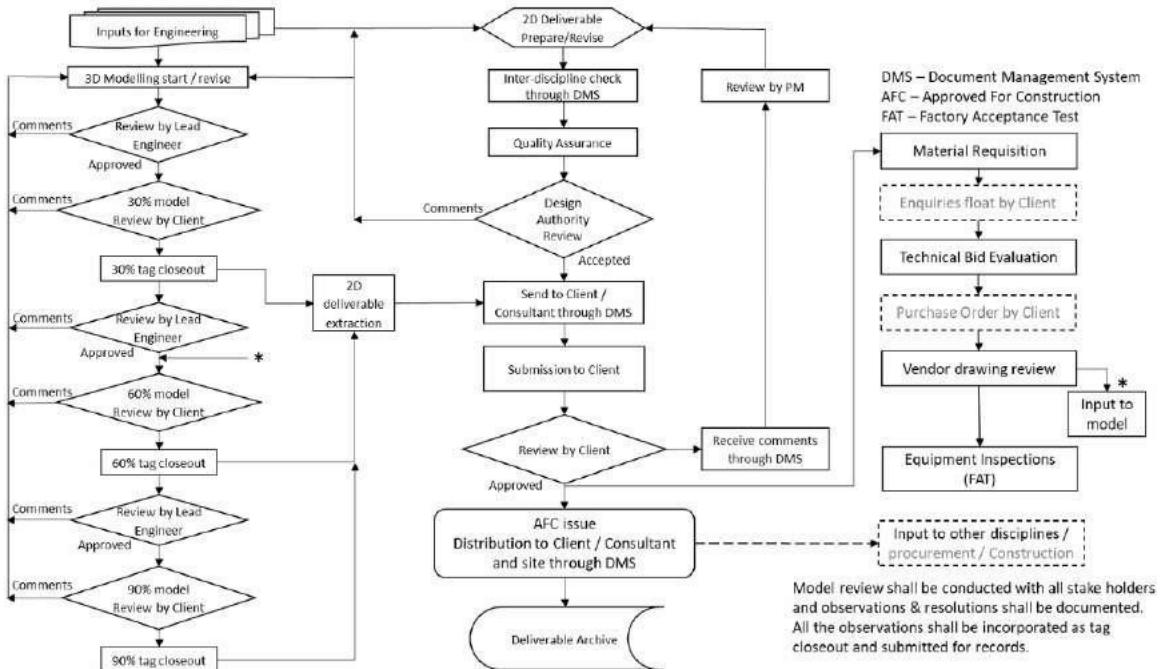
Topic details:

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 commands

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	EXTENDED	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+O	HORIZONTAL	HOR			
COMMAND WIN	Ctrl+9	VERTICAL	VER			



Topic details:

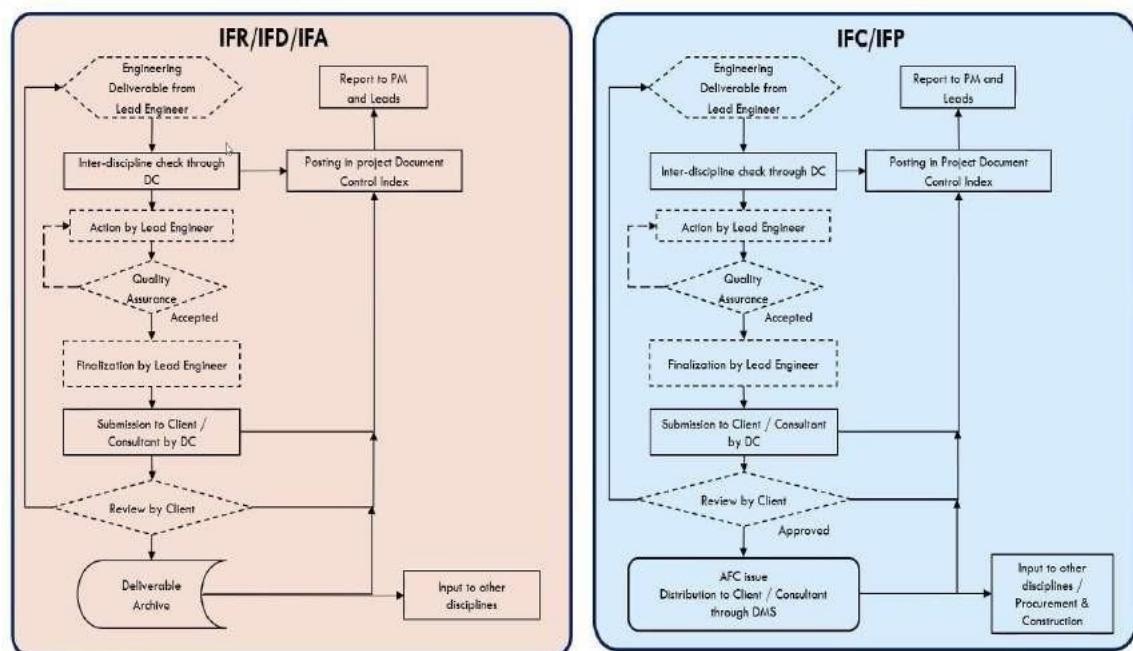
Here we need to learn the basis of the autocad basic keys like standard, modify, draw, format, paper size etc..

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.

10th May 2021: Engineering documentation for Typical diagrams

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

Topic details:

We conclude here how to do load calculations and Typical diagrams and internal structure and also about the power flow diagram.

11th May 2021: Classification of Transformers and Generators

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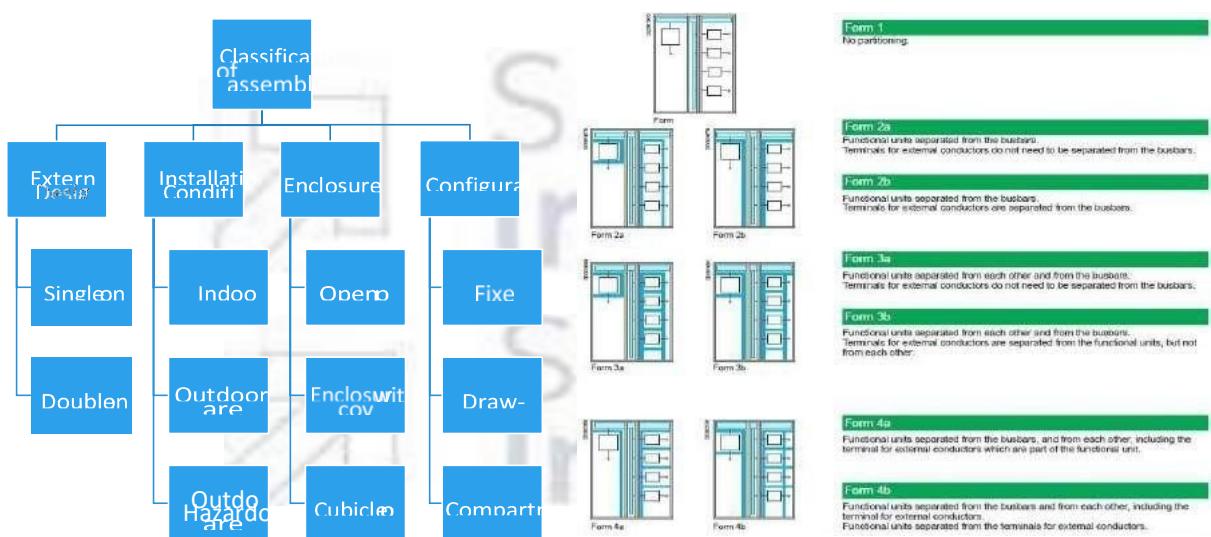


Topic details:

Classification of Transformers and Generators

12th May 2021: 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
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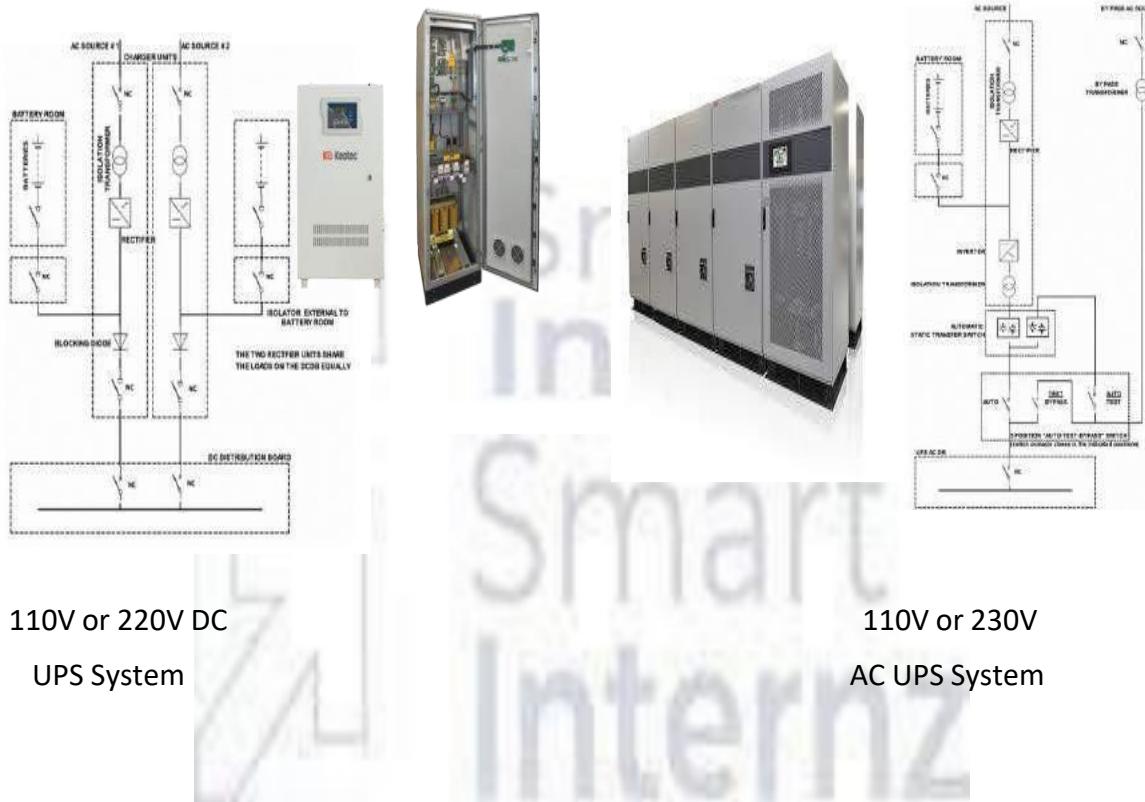


Topic details:

Classification of Switchgare construction and Power Factor Improvement

17th May 2021: Detailing about UPS system and Busducts.

8	Detailing about UPS system and Busducts	Uninterruptible power supply system	Busducts of the system
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110V or 220V DC
UPS System

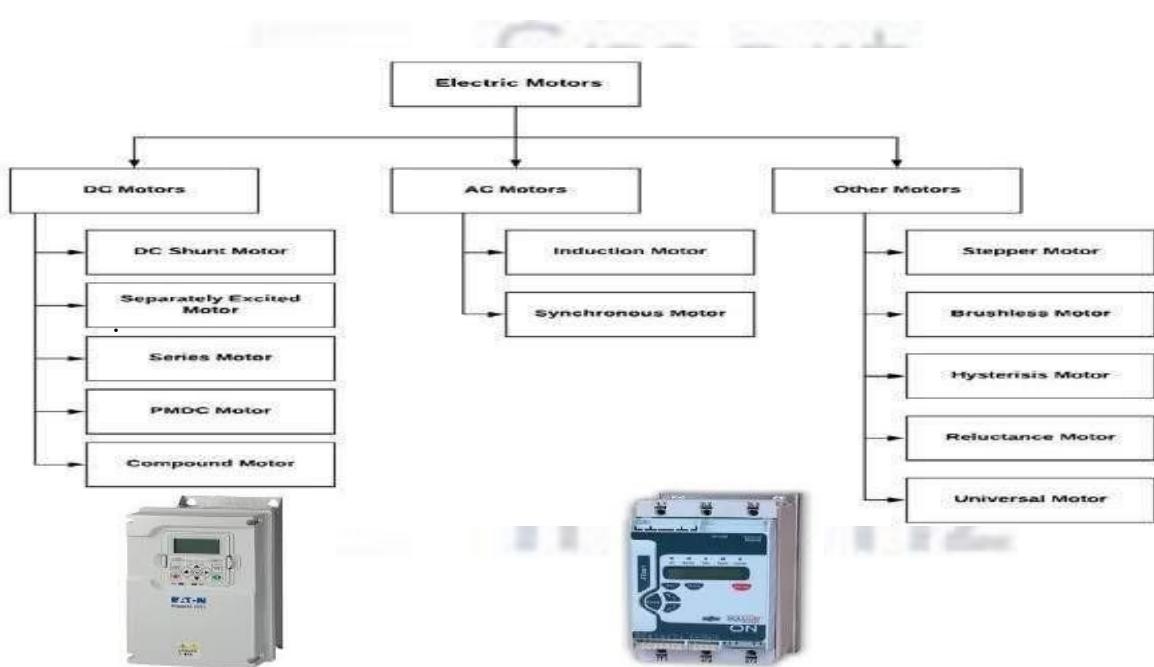
110V or 230V
AC UPS System

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

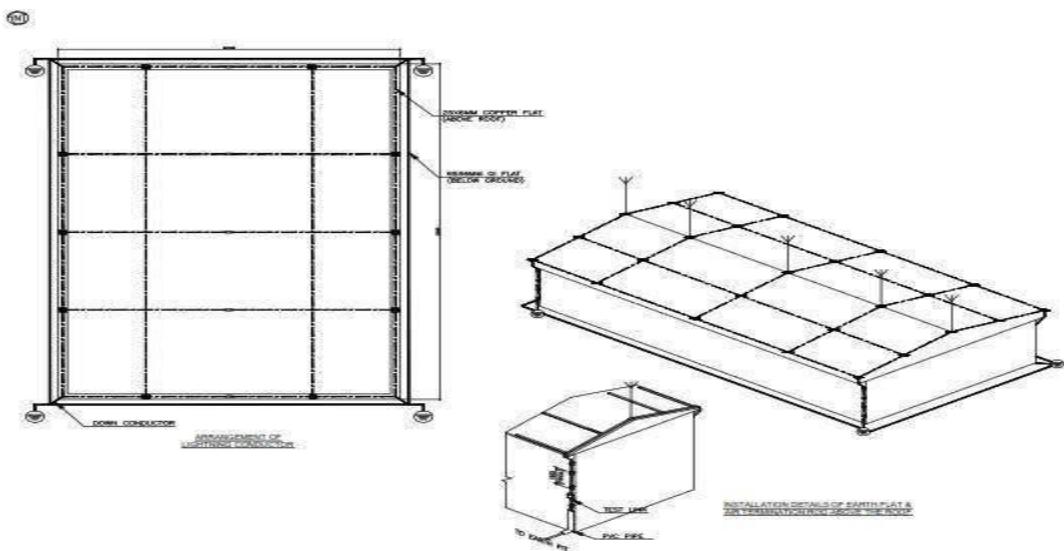
The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is 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 May 2021: 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.

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 May 2021: 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, 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.

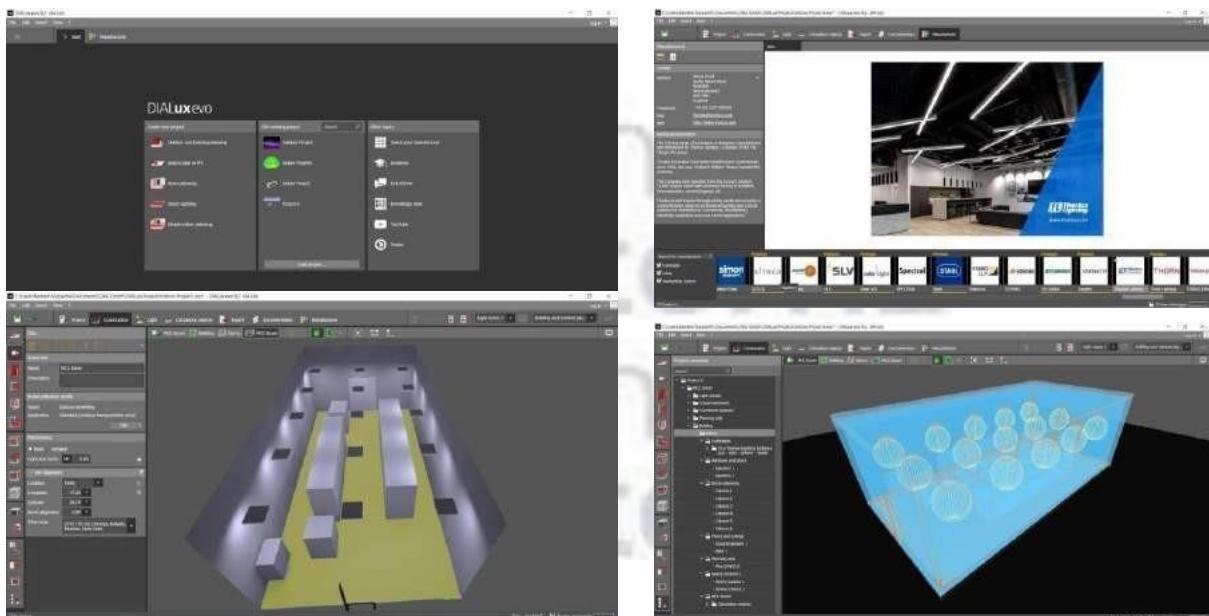
Types of light fittings: Industrial, flame proof type (EX d), increased safety type (Ex e).

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

12	Lighting or Illumination using DIALUX software	Lighting or illumination systems	Operation of dialux
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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 May 2021: Cabling and their calculations and types.

13	Cabling and their types and claculations	Cabling calculations	Types of cabling materials
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Topic details: Cabling and their types and claculations .



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 May 2021: Cabling calculations and Cable gland selection.

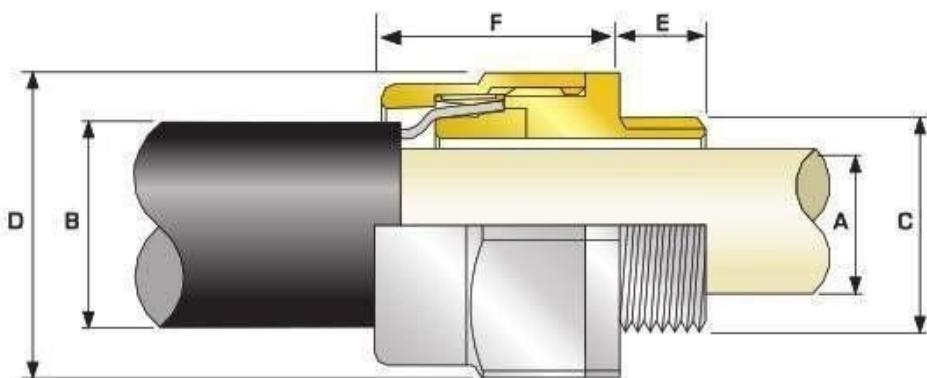
14	Cabling calculations and cable gland selection	Cabling calculations	Cable gland selection
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Topic details: Cable sizing calculation and cable gland selection.

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 May2021: Load calculations and Transformer sizing calculations

15	Load calculations and TR calculations	Load calculations	TR calculations
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Topic details:

List of electrical load calculations.

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 [C]	Efficiency at Load Factor [C]	Power Factor at Load Factor [C]	$KW = A / D $	Consumed Load			$KVAR = KW \times \tan \phi$			Remarks
													kW	kW	decimal	kW	kVAR		
1	PU2315	Silica filter feed pump					33.15	37.00	0.90	0.91	0.78	36.43	29.23						
2	PU 2314-A	Absorbent/Neutral oil pump (W)					9.63	11.00	0.88	0.85	0.73	11.3	10.6						
3	PU 2314-B	Absorbent/Neutral oil pump (S)					8.29	9.20	0.90	0.85	0.73							9.8	
4	PU 2314-C	Pump (Water separator)					33.44	37.00	0.90	0.91	0.78	36.8	29.5						
5	MX2305	MIXER (W)					33.74	37.00	0.91	0.91	0.78	37.1	29.7						
6	MX 2308	MIXER (S)					33.74	37.00	0.91	0.91	0.78							37.1	
7	BW2313	Blower					14.49	15.00	0.97	0.85	0.73	17.0	16.0						
8	Rotary valve	N 2313B (0)					1.41	1.40	0.94	0.85	0.75							1.7	
9	AG 2314	Scrubber conveyor (I)					3.95	3.70	0.89	0.85	0.73							1.6	
10	AG 2324AA	Citric acid tank agitator (W)					2.44	3.00	0.81	0.85	0.73	2.87	2.69						
11	AG 2324B	Citric acid tank agitator (S)					2.44	3.00	0.81	0.85	0.73							2.9	
12	AG 2305	Citric oil reaction vessel agitator					8.89	9.20	0.97	0.85	0.73	10.40	9.79						
13	AG 2309	Lye oil reaction vessel agitator					3.23	3.70	0.87	0.85	0.73	3.85	3.56						
14	AG 2310	Lye oil reaction vessel agitator					3.23	3.70	0.87	0.85	0.73	3.80	3.56						
15	AG 2314	Soap Absorbent Tank Agitator					5.65	7.50	0.75	0.85	0.73	6.65	6.22						
Maximum of normal running plant load : (Est. $\sqrt{3}E + y\sqrt{F}$)																			
167.9 kW																			
Peak Load : (Est. $\sqrt{3}E + y\sqrt{F} + z\sqrt{G}$)																			
172.9 kW																			
sgt (kW + kVAR) = 220.2 kVA																			
TOTAL																			
166.25 140.87 5.48 5.13 49.70 41.56																			
KVA																			
217.91 7.51 64.79 3.75 217.91 7.51																			
217.91 7.51 64.79 3.75 217.91 7.51																			
Assumptions																			
1) Load factor, Efficiency and Power factor: Load rating (kW) => 20 > 20 - > 45 > 45 - > 150 => 150																			
Efficiency 0.85 0.79 0.91 0.78 0.93 0.82 0.94 0.91																			
Power factor --- (i) --- (ii) --- (iii)																			
2) Coincidence factors x=1.0, y= 0.3, and z=0.1 considered for continuous, intermittent and standby load.																			

T/F calculation:

Calculation for Transformer Capacity			Assignment - 2																																
1. Example of calculation for Transformer Capacity																																			
1.1 Calculation for consumed load																																			
Consumed loads used for this example are as follows :																																			
<table border="1"> <thead> <tr> <th></th> <th>KW</th> <th>KVar</th> <th>KVA</th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>a. Continuous load</td> <td>166.25</td> <td>140.9</td> <td>217.91</td> <td>---</td> <td>(i)</td> </tr> <tr> <td>b. Intermittent load / Diversity Factor</td> <td>5.48</td> <td>5.1</td> <td>7.51</td> <td>---</td> <td>(ii)</td> </tr> <tr> <td>c. Stand-by load required as consumed load</td> <td>49.7</td> <td>41.6</td> <td>64.79</td> <td>---</td> <td>(iii)</td> </tr> </tbody> </table>							KW	KVar	KVA			a. Continuous load	166.25	140.9	217.91	---	(i)	b. Intermittent load / Diversity Factor	5.48	5.1	7.51	---	(ii)	c. Stand-by load required as consumed load	49.7	41.6	64.79	---	(iii)						
	KW	KVar	KVA																																
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c. Stand-by load required as consumed load	49.7	41.6	64.79	---	(iii)																														
Max. Consumed load = (i) + 30% (ii) + 10% (iii) = 170.9																																			
Future expansion load (20% capacity) = 34.6																																			
Total Load = 207.4																																			
<table border="1"> <thead> <tr> <th></th> <th>KW</th> <th>KVar</th> <th>KVA</th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>Max. Consumed load</td> <td>226.6</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Spare capacity</td> <td></td> <td>48.3</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Require capacity</td> <td></td> <td></td> <td>272.0</td> <td>KVA</td> <td></td> </tr> <tr> <td>Transformer rated capacity</td> <td></td> <td></td> <td>300</td> <td>KVA</td> <td></td> </tr> </tbody> </table>							KW	KVar	KVA			Max. Consumed load	226.6					Spare capacity		48.3				Require capacity			272.0	KVA		Transformer rated capacity			300	KVA	
	KW	KVar	KVA																																
Max. Consumed load	226.6																																		
Spare capacity		48.3																																	
Require capacity			272.0	KVA																															
Transformer rated capacity			300	KVA																															
1.2 Calculation for 33kV / 0.433 kV transformer capacity																																			
During starting or reacceleration of max. capacity motor (3400 kW) , while all the other loads running , the voltage regulation																																			
PT = 300 KVA (%R)= 2 & Ratio X/R = 1.5																																			
Hence , %R = 1.109 %																																			
%X = 1.66 %																																			
PM = 37 KW having (K = 8 & C = 1 & Cos θ = 0.74 & Eff h = 0.87 & Cos Qs = 0.25)																																			
PS = 344.872 KVA																																			
Cos 6S = 0.25, Corresponding to Angle 6s = 75.322 Degrees for which Sin 6s = 0.97																																			
PB = 180.43 KVA & PS in KVA = 116.711 & PB in Kvar = 107.9 & Cos 6S = 0.74																																			
Cos 6B = 0.85 , Corresponding to Angle 6s = 26.564 Degrees, for which Sin 6s = 0.98																																			
PCP = 204.925 KVA																																			
PDP = 44.722 KVAR																																			
PC = 496.99 KVA																																			
Cos 6C = 0.4207 , where as Sin 6C = 0.907																																			
Voltage Regulation e = 3.2 %																																			
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																																			
300 kVA transformer selected.																																			

29th May2021: DG set calculations

16	DG set calculations
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Topic details:

Transformer and DG set calculations, types, sizing or selections

Assignment - 3		
DG SIZING CALCULATIONS		
Design Data		
Rated Voltage	415	KV
Power factor ($\cos\theta$)	0.74	Avg
Efficiency	0.87	Avg
Total operating load on DG set in kVA at 0.74 power factor	272.0	
Largest motor to start in the sequence - load in kW	37	KW
Running KVA of last motor ($\cos\theta = 0.91$)	57	KVA (Considering starting method as Soft starter)
Starting current ratio of motor	6	
Starting KVA of the largest motor (Running KVA of last motor X Starting current ratio of motor)	345	KVA
Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	215	KVA
A Continuous operation under load -P1		
Capacity of DG set based on continuous operation under load P1	215	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)	559	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 $P_2 = \text{Total momentary load in KVA} \times X_d''' \times \frac{(1-\text{Transient Voltage})}{(\text{Transient})}$	285	KVA
C Overload capacity P3		
Capacity of DG set required considering overload capacity		
Total momentary load in KVA	559	KVA
overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
Capacity of DG set required considering overload capacity ($P_3 = \frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$)	373	KVA
Considering the last value amongst P1, P2 and P3		
Continuous operation under load -P1	215	KVA
Transient Voltage dip during Soft starter starting of Last motor P2	285	KVA
Overload capacity P3	373	KVA
Considering the last value amongst P1, P2 and P3	373	KVA
Hence, Existing Generator 373 KVA is adequate to cater the loads as per re-scheduled loads		
NOTE: VOLTAGE DIP CONSIDERED - 15%		

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

Assignment - 5 Lightning Calculations	
Location	Concrete Industrial
Building	Flat Roofed (x)
Type of building	14
Building Length (L)	8
Building breadth (W)	5
Building height (H)	5
Risk Factor Calculation	
1 Collection Area (Ac)	= $(0.4W) \times (2(LH)) \times (2(WH)) \times (2.14H^{1.6})$ 410.5
P	= $A_c \times 10^{-4}$ 0.000082
2 Overall weighting factor	
a) Type of structure (A)	x 1.0
b) Type of construction (B)	x 0.4
c) Contents or consequential effects (C)	x 0.8
d) Degree of isolation (D)	x 1.0
e) Type of country (E)	x 0.3
We - Overall weighting factor	= $A \times B \times C \times D \times E$ 0.096
4 Overall Risk Factor	= $P \times W_o$ 0.000082 $P_o = 10^{-4}$
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	
Perimeter of the building	= $2(L+W)$ = 44 Mts.
6 Down Conductors	
Perimeter of building	= 44 Mts.
No. of down conductors based on perimeter	= 2 Nos.
Hence 2 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 conductor = 20mm X 2.5 mm Galvanized Steel Strip)	

Earthing calculation

2	
Maximum line-to-ground fault in kA for 1 sec	12
Earthing material (Earth rod & earth strip)	01
Depth of earth rod burial in meter	0.5
Average depth / length of Earth rod in meters	3.5
Soil resistivity in ohm meter	13
Ambient temperature in deg C	45
Plot dimensions (earth grid) L x B in meters	60 120
Number of earth rods in nos.	6
Earth electrode sizing	
Ac - Required conductor cross section in sq.mm	
$I_{ig} = A_c \sqrt{\frac{[TCAP(10^{-4}) \times L \times (K_p + T_p)]}{[T_a \times \pi \times K_p]}}$	0.0032
or - Thermal coefficient of resistivity, at 20 oC	0.0032
pr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is "C	45
Ig - RMS fault current in kA = 50 KA	12
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
Ko - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
$I_{ig} = Ac *$	0.123
Ac - Required conductor cross section in sq.mm	98
Earth rod dia in mm	11
Earth rod dia (including 25% corrosion allowance) in mm	14
Earth flat sizing:	
Ac - Required conductor cross section in sq.mm	
$I_{ig} = A_c \sqrt{\frac{[TCAP(10^{-4}) \times L \times (K_p + T_p)]}{[T_a \times \pi \times K_p]}}$	0.0032
or - Thermal coefficient of resistivity, at 20 oC	0.0032
pr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is "C	45
Ig - RMS fault current in kA = 50 KA	12
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
Ko - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
$I_{ig} = Ac *$	0.123
Ac - Required conductor cross section in sq.mm	98
Earth flat area (mm)	11
Earth flat area (including 25% corrosion allowance) in mm	14
Selected flat size W * Thk in sq mm	20
Grounding system resistance	
Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:	
$R_g = \frac{R_g \times R_2 \times R_m^2}{R_g + R_2 + 2R_m}$	
Rm - Mutual ground resistance between the group of ground conductors, Rg and group of electrodes, Rr in ohm. Neglected Rm, since this is for homogenous soil	
Rr - Total earthing system resistance	0.102 Ohms
The calculated resistance grounding system is less than the allowable 1.0 value.	

5 th june 2021: Cable sizing and cable tray sizing calculations.

18	Cable sizing and cable tray sizing calculations	Cable sizing calculations	Cable tray calculation
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Topic details:

Cable sizing and cable tray sizing calculations for LV cables and MV/HV cables.

Assignment - 7		Assignment - 8																								
S.NO.	Equipment	Cable Sizing												Cable Sizing												
		Load, KW	Load, Amps	Voltage	Temp	Temp	Max Temp	Temp Factor	% Min	Min Load	Min %	Type	No. of Cables	Min. Current Carrying Capacity	Min Rating Factor	Min Rating Capacity	Min Rating Current	Min Rating Power								
1	PUC311-A Silica Water feed pump	33.15	37.00	415	9	57.6	345.90	9.8	0.6	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.862	107.6	95	0.9300	0.0816	2.52	1.81
2	PUC311-A Silica Water feed pump (2)	33.15	37.00	415	9	57.6	345.90	9.8	0.6	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.862	107.6	95	0.9300	0.0816	2.52	1.81
3	PUC311-B Absorber/Heat exchangers (3)	8.25	9.70	415	3	14.4	84.50	9.8	0.6	0.5	2	1	4.0	8	51	0.98	0.9	1	1	0.862	45.0	60	0.9400	0.0902	4.80	1.16
4	PUC305 Feed Pump (Separator)	33.48	37.00	415	3	58.2	349.34	9.8	0.6	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.862	107.6	95	0.9300	0.0816	6.80	1.64
5	M230503 Mixer (V)	33.48	37.00	415	3	58.2	349.34	9.8	0.6	0.5	2	1	4.0	16	122	0.98	0.9	1	1	0.862	54.4	23.5	0.9400	0.0902	3.44	2.25
6	M230503 Mixer (V)	33.48	37.00	415	3	58.2	349.34	9.8	0.6	0.5	2	1	4.0	16	122	0.98	0.9	1	1	0.862	107.6	105	0.9315	0.0816	2.52	1.11
7	BW2318 Boiler	14.09	15.00	415	3	25.2	151.19	9.8	0.6	0.5	2	1	4.0	10	66	0.98	0.9	1	1	0.862	50.2	100	2.3400	0.0852	3.89	2.02
8	Rotary valve	23.331B	23.331B	1	1	1.5	25.1471	9.8	0.6	0.5	2	1	4.0	1.5	22	0.98	0.9	1	1	0.862	19.4	100	15.5000	0.1080	5.29	1.38
9	SC2310 String filter (10)	3.75	4.75	415	3	5.7	33.91	9.8	0.6	0.5	2	1	4.0	1.5	22	0.98	0.9	1	1	0.862	19.4	100	15.5000	0.1080	5.29	1.38
10	SC2310 String filter (10)	3.75	4.75	415	3	5.7	33.91	9.8	0.6	0.5	2	1	4.0	1.5	22	0.98	0.9	1	1	0.862	19.4	100	15.5000	0.1080	5.29	1.38
11	AC224B Ozone add. rate system (4)	2.44	3.00	415	3	4.2	25.146	9.8	0.6	0.5	2	1	4.0	1.5	22	0.98	0.9	1	1	0.862	75	15.0000	0.0902	0.0856	4.67	1.16
12	AD2305 Ammonia injection vessel agitator	8.89	9.26	415	3	9.8	92.76	9.8	0.6	0.5	2	1	4.0	5	51	0.98	0.9	1	1	0.862	45.0	165	0.9400	0.0902	1.61	2.77
13	AD2305 Ammonia injection vessel agitator	8.89	9.26	415	3	9.8	92.76	9.8	0.6	0.5	2	1	4.0	15	122	0.98	0.9	1	1	0.862	107.6	105	0.9315	0.0816	2.52	0.98
14	AD2310 Ammonia injection vessel agitator	3.25	3.75	415	3	5.4	33.79	9.8	0.6	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.862	24.7	65	9.8000	0.1007	2.07	1.70
15	AD2314 Spare Ammonium Tank Agitator	5.65	7.50	415	3	9.8	58.85	9.8	0.6	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.862	24.7	65	9.8000	0.1007	8.46	2.04

Basic:

- Overall derating factor $k = k_1 \cdot k_2 \cdot k_3 \cdot k_4$
 - k_1 : Rating factor for variation in air/ground temperature
 - k_2 : Rating factor for depth of laying
 - k_3 : Rating factor for spacing between two circuits
 - k_4 : Rating factor for variation in thermal resistivity of the soil
- LT Motors : Running Voltage $\Delta U = 3\%$, Starting Voltage $\Delta U = 15\%$
- Cable type

TYPE 1: All Conductor, XLPE Insulated, Armoured, PVC outer sheath
TYPE 2: Cu Conductor, XLPE insulated, Armoured, PVC outer sheath
- Effect of Frequency Variation $\pm 5\%$

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

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 :

	kW	kVar	kVA	
a. Continuous load	166.25	140.9	217.91	---
b. Intermittent load / Diversity Factor	5.48	5.1	7.51	---
c. Stand-by load required as consumed load	49.7	41.6	64.79	---
Max. Consumed load = (i) + 30% (ii) + 10% (iii)	172.9	146.6	226.63	
Future expansion load (20% capacity)	34.6	29.3	45.33	
Total Load =	207.4	175.9	271.96	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

$$\begin{aligned} \text{Max. Consumed load} &= 226.6 \text{ kVA} \\ \text{Spare capacity} &= 45.3 \text{ kVA} \\ \text{Required capacity} &= 272.0 \text{ kVA} \\ \text{Transformer rated capacity} &= 300 \text{ kVA} \end{aligned}$$

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 : e

$$PT = 300 \text{ kVA} \quad (\%Z) = 2 \quad \& \text{Ratio } X/R = 1.5$$

$$\text{Hence, } \%R = 1.109 \%$$

$$\%X = 1.66 \%$$

$$\begin{aligned} PM &= 37 \text{ kW having } (K = 6) \quad \& C = 1 \quad \& \cos \theta = 0.74 \quad \& \text{Eff.h} = 0.87 \quad \& \cos Qs = 0.25 \\ PS &= 344.82 \text{ kVA} \end{aligned}$$

$$\begin{aligned} \cos \theta_S = 0.25, \text{ Corresponding to Angle } \theta_S &= 75.522 \text{ Degrees for which } \sin \theta_S = 0.97 \\ &= 160.43 \text{ kVA} \quad \& PB \text{ in kVA} = 118.718 \quad \& PB \text{ in kVar} = 107.9 \quad \& \cos \theta_B = 0.740 \\ \cos \theta_B = 0.85, \text{ Corresponding to Angle } \theta_B &= 268.584 \text{ Degrees, for which } \sin \theta_B = 0.67 \end{aligned}$$

$$\begin{aligned} PCP &= 204.92 \text{ kW} \\ PCQ &= 441.77 \text{ kVAR} \\ PC &= 486.99 \text{ kVA} \end{aligned}$$

$$\cos \theta_C = 0.42079, \text{ where as } \sin \theta_C = 0.907$$

$$\text{Voltage Regulation e} = 3.2 \%$$

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

300 kVA transformer selected.

PBHP	= Absorbed load (kW)
h	= Load efficiency
Cos q	= Load Power Factor
PP	= Consumed Active Power (kW)
PQ	= Consumed Reactive Power (kVar)
P	= Consumed Apparent Power (kVA)
PB	= Base load (kVA)
Cos qB	= Power Factor of base load
PM	= Rated output of largest motor (kW)
PS	= Starting capacity of largest motor
Cos qS	= Starting power factor of largest motor
K	= Current ratio of motor (= starting current / rated current)
C	= Reduced current ratio of motor starting current (1 for DOL start, 0.33 for Y-D start, tap p.u. For reactor or auto transformer)
%R	= Percent resistance for transformer
%X	= Percent reactance for transformer
PCP	= Active Power of combined load (kW)
PCQ	= Reactive Power of combined load (kVar)
PC	= Apparent Power of combined load (kVA)
Cos qC	= Power Factor of combined load
PT	= Transformer rated capacity (kVA)
	= Voltage Regulation of transformer

Percent R, X and Z based on Transformer KVA

Transformer Rating KVA	X/R	R %	X %	Z %
150	3.24	1.23	4.0	4.19
175	3.24	1.23	4.0	4.17
200	3.50	1.11	4.0	4.16
250	3.85	1.04	4.0	4.12
300	4.45	0.94	5.1	5.19
350	5.70	0.89	5.1	5.19
400	6.15	0.83	5.5	5.19
2000	6.63	0.77	5.1	5.17
150	1.5	1.11	1.665	2.0
225	1.5	1.11	1.665	2.0
300	1.5	1.11	1.665	2.0
500	1.5	1.11	1.665	2.0

Note 1: These values are for three phase, liquid filled, self-cooled transformers.

Note 2: Due to the trend toward lower impedance transformers for better voltage regulation, the actual transformer impedances may deviate from the NEMA Standard given at left. Therefore, for actual values, obtain nameplate impedance from owner or manufacturer. The percent X and percent R values are desirable for calculation.

Absorbed Load (PBHP)

Motor : For medium / large machines , "Load BHP" column of " Motor / Load requirement s be referred .

For small machines , the values may generally be estimated as follows :

$$\text{Rated output (kW)} \times \text{Demand Factor (standard value 0.85)}$$

Other Loads : For instrumentation , computer , communication , air conditioning , lighting , etc. estimated as follows :

$$\text{Rated kVA} \times \text{Power Factor} \times \text{Demand Factor}$$

Consumed Load

$$\text{Active Power PP} = \frac{S \cdot PBHP}{h} \quad (\text{kW})$$

$$\text{Reactive Pow PQ} = \frac{S \cdot PBHP}{h} \times \tan \theta \quad (\text{kVar})$$

$$\text{Apparent pow P} = \sqrt{PP^2 + PQ^2} \quad (\text{kVA})$$

$$\text{Voltage Regulation e} = \frac{PC \times (\%R \cdot \cos \theta_C + \%X \cdot \sin \theta_C)}{PT} \quad \text{in (\%)}$$

$$\text{where } PC = \sqrt{PCP^2 + PCQ^2} \quad (\text{kVA})$$

$$PCP = PB \cdot \cos \theta_B + PS \cdot \cos \theta_B \quad (\text{kW})$$

$$PCQ = PB \cdot \sin \theta_B + PS \cdot \sin \theta_B \quad (\text{kVar})$$

$$PS = K \cdot C \cdot \frac{PM}{\cos \theta \cdot \eta}$$

$$\cos \theta = \frac{PCP}{PC}$$

$$\sin \theta = \frac{PCQ}{PC}$$

Assignment - 3

DG SIZING CALCULATIONS		
Design Data		
Rated Volatge	415	KV
Power factor ($\cos\theta$)	0.74	Avg
Efficiency	0.87	Avg
Total operating load on DG set in kVA at 0.74 power factor	272.0	
Largest motor to start in the sequence - load in KW	37	KW
Running KVA of last motor ($\cos\theta = 0.91$)	57	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)	345	KVA
Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	215	KVA
A Continous operation under load -P1		
Capacity of DG set based on continuous operation under load P1	215	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)	559	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 $P_2 = \text{Total momentary load in KVA} \times X_d''' \times (1 - \text{Transient Voltage})$ (Transient)	285	KVA
C Overload capacity P3		
Capacity of DG set required considering overload capacity		
Total momentary load in KVA	559	KVA
overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
Capacity of DG set required considering overload capacity ($P_3 = \frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$)	373	KVA
Considering the last value amongst P1, P2 and P3		
Continous operation under load -P1	215	KVA
Transient Voltage dip during Soft starter starting of Last motor P2	285	KVA
Overload capacity P3	373	KVA
Considering the last value amongst P1, P2 and P3	373	KVA
Hence, Existing Generator 373 KVA is adequate to cater the loads as per re-scheduled loads		
NOTE: VOLTAGE DIP CONSIDERED - 15%		

Table 1—Material constants

Description	Material conductivity (%)	α_r factor at 20 °C (1/°C)	K_0 at 0 °C (0 °C)	Fusing ^a temperature T_m (°C)	ρ_{20} °C ($\mu\Omega \cdot \text{cm}$)	TCAP thermal capacity [J/(cm ³ ·°C)]
Copper, annealed soft-drawn	100.0	0.00393	234	1083	1.72	3.42
Copper, commercial hard-drawn	97.0	0.00381	242	1084	1.78	3.42
Copper-clad steel wire	40.0	0.00378	245	1084	4.40	3.85
Copper-clad steel wire	30.0	0.00378	245	1084	5.86	3.85
Copper-clad steel rod ^b	20.0	0.00378	245	1084	8.62	3.85
Aluminum, EC grade	61.0	0.00403	228	657	2.86	2.56
Aluminum, 5005 alloy	53.5	0.00353	263	652	3.22	2.60
Aluminum, 6201 alloy	52.5	0.00347	268	654	3.28	2.60
Aluminum-clad steel wire	20.3	0.00360	258	657	8.48	3.58
Steel, 1020	10.8	0.00160	605	1510	15.90	3.28
Stainless-clad steel rod ^c	9.8	0.00160	605	1400	17.50	4.44
Zinc-coated steel rod	8.6	0.00320	293	419	20.10	3.93
Stainless steel, 304	2.4	0.00130	749	1400	72.00	4.03

^aFrom ASTM standards.

^bCopper-clad steel rods based on 0.254 mm (0.010 in) copper thickness.

^cStainless-clad steel rod based on 0.508 mm (0.020 in) No. 304 stainless steel thickness over No. 1020 steel core.

Maximum line-to-ground fault in kA for 1 sec	2
Earthing material (Earth rod & earth strip)	12
Depth of earth flat burial in meter	0.5
Average depth / length of Earth rod in meters	3.5
Soil resistivity Ω-meter	13
Ambient temperature in deg C	45
Plot dimensions (earth grid) L x B in meters	60 120
Number of earth rods in nos.	6

Earth electrode sizing:
Ac - Required conductor cross section in sq.mm

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
pr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	45
Il-g - RMS fault current in kA = 50 KA	12
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:	
12 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	98
Earth rod dia in mm	11
Earth rod dia (including 25% corrosion allowance) in mm	14

Earth flat sizing:
Ac - Required conductor cross section in sq.mm

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
pr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	45
Il-g - RMS fault current in kA = 50 KA	12
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:	
12 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	98
Earth flat area in mm	11
Earth flat area (including 25% corrosion allowance) in mm	14
Selected flat size W * Thk in sq mm	20

Rg - Grid resistance

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

$$R_g = \rho \frac{1}{L} \frac{1}{\sqrt{20 \times A}} \frac{1}{1} \frac{1}{h} \frac{1}{\sqrt{20 \times A}}$$

ρ - Soil resistivity in Ω-meter=	13
L - Total buried length of ground conductor in meter	360
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	7200

Rg - Grid resistance 0.104

Rr - Earth Electrode resistance

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

$$R_r = \frac{\rho}{2 \times \pi \times n_r \times L_r} \ln \frac{4 \times L_r}{b} - 1 - \frac{2 \times k_1 \times L_r}{\sqrt{A}} \sqrt{n_r} - 1^2$$

ρ - Soil resistivity in Ω-meter, 16.96	13
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	3.5
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	7200

Rr - Earth Electrode resistance 5.604718

Grounding system resistance

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

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

Rm - Mutual ground resistance between the group of ground conductors, Rg and group of electrodes, Rr in Ω. Neglected Rm, since this is for homogenous soil

Rs - Total earthing system resistance 0.102 Ohms

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

Assignment - 5
Lightning Calculations

Location	surat
Building	Concrete, Industrial
Type of Building	Flat Roofs (a)
Building Length (L)	14
Building breadth (W)	8
Building Height (H)	5

Risk Factor Calculation

1 Collection Area (Ac)

$$Ac = (L \cdot W) + (2 \cdot L \cdot H) + (2 \cdot W \cdot H) + (3.14 \cdot H^2)$$

$$= 410.5$$

2 Probability of Being Struck (P)

$$P = Ac \cdot Ng \cdot 10^{-6}$$

$$= 0.000082$$

3 Overall weighing factor

a) Use of structure (A)	=	1.0
b) Type of construction (B)	=	0.4
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	=	$A \cdot B \cdot C \cdot D \cdot E$
	=	0.096

4 Overall Risk Factor

$$Po = P \cdot Wo$$

$$Po = 0.000008$$

$$Pa = 10^{-5}$$

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

$$\text{Perimeter of the building} = 2(L+W)$$

$$= 44 \quad \text{Mts.}$$

6 Down Conductors

$$\text{Perimeter of building} = 44 \quad \text{Mts.}$$

$$\text{No. of down conductors based on perimeter} = 2 \quad \text{Nos.}$$

Hence 2 nos. of Down conductors have been selected.

$$\text{Size of Down conductor} = 20 \times 2.5 \text{ mm Galvanized Steel Strip}$$

(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)

— 1 —

asis:

Overall derating factor $k = k_1 \times k_2 \times k_3 \times k_4$

=Rating factor for variation in air/ground temperature

=Rating factor for depth of laying

-Rating factor for spacing between two circuits

Rating factor for variation in thermal resistivity of the soil

L-T Motors e-Bus: Maximum Voltage Drop = 3% - Starting Voltage Drop = 15%

127 Motore + Ram

E 1. Al conductor, XLPE insulated, Armored, PVC outer sheathed

Effect of Frequency Variation $\pm 5\%$

Assignment - 7

Cable Tray Sizing

LT CABLES

CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No.	Cable Route (From-To)	Type & Cable Size	Size of Cable (mm ²)	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	PU2315	2	25	1	22	22	1.4	1.4	
2	PU 2314-A	2	6	1	18	18	0.7	0.7	
3	PU 2314 -B	2	6	1	18	18	0.7	0.7	
4	PU2305	2	25	1	22	22	1.4	1.4	
5	MX2305	2	16	1	21	21	1	1	
6	MX 2308	2	25	1	22	22	1.4	1.4	
7	BW2313	2	10	1	18	18	0.9	0.9	
8	Rotary valve	2	1.5	1	15	15	0.4	0.4	
9		2	1.5	1	15	15	0.4	0.4	
10	SC2314	2	1.5	1	15	15	0.4	0.4	
11		2	1.5	1	15	15	0.4	0.4	
12	AG 2324B	2	6	1	18	18	0.7	0.7	
13	AG 2305	2	1.5	1	15	15	0.4	0.4	
14	AG 2309	2	2.5	1	16	16	0.5	0.5	
15	AG 2310	2	2.5	1	16	16	0.5	0.5	
Total				15		266	11.2	11.2	

Calculation

Maximum Cable Diameter:

22 mm

Consider Spare Capacity of Cable Tray:

30%

Distance between each Cable:

0 mm

Calculated Width of Cable Tray:

346 mm

Calculated Area of Cable Tray:

7608 Sq.mm

No of Layer of Cables in Cable Tray:

1

Selected No of Cable Tray:

1 Nos.

Selected Cable Tray Width:

600 mm

Selected Cable Tray Depth:

100 mm

Selected Cable Tray Weight Capacity:

90 Kg/Meter

Type of Cable Tray:

Ladder

Total Area of Cable Tray:

60000 Sq.mm

Result

Selected Cable Tray width:

O.K

Selected Cable Tray Depth:

O.K

Selectrd Cable Tray Weight:

O.K

Including Spare Capacity

Selected Cable Tray Size:

O.K

Including Spare Capacity

Required Cable Tray Size:

600 x 100 mm

Required Nos of Cable Tray:

1 No

Required Cable Tray Weight:

90.00 Kg/Meter/Tray

Type of Cable Tray:

Ladder

Cable Tray Width Area Remaning

42%

Cable Tray Area Remaning:

87%