Internship Program Report

By

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GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)
(Sponsored by A. A. N. M & V. V. R. S. R Educational Society, Gudlavalleru)
Approved by AICTE, New Delhi and Permitted by AP State Government
Accredited by NAAC with 'A' Grade

Counselling Code : GDLV

In association with

Smart Internz

Contents

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

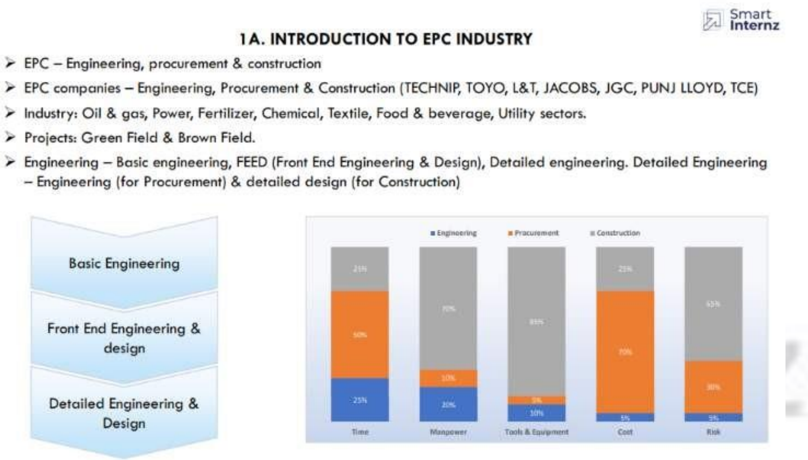
Presenter: Mr Ramesh V

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



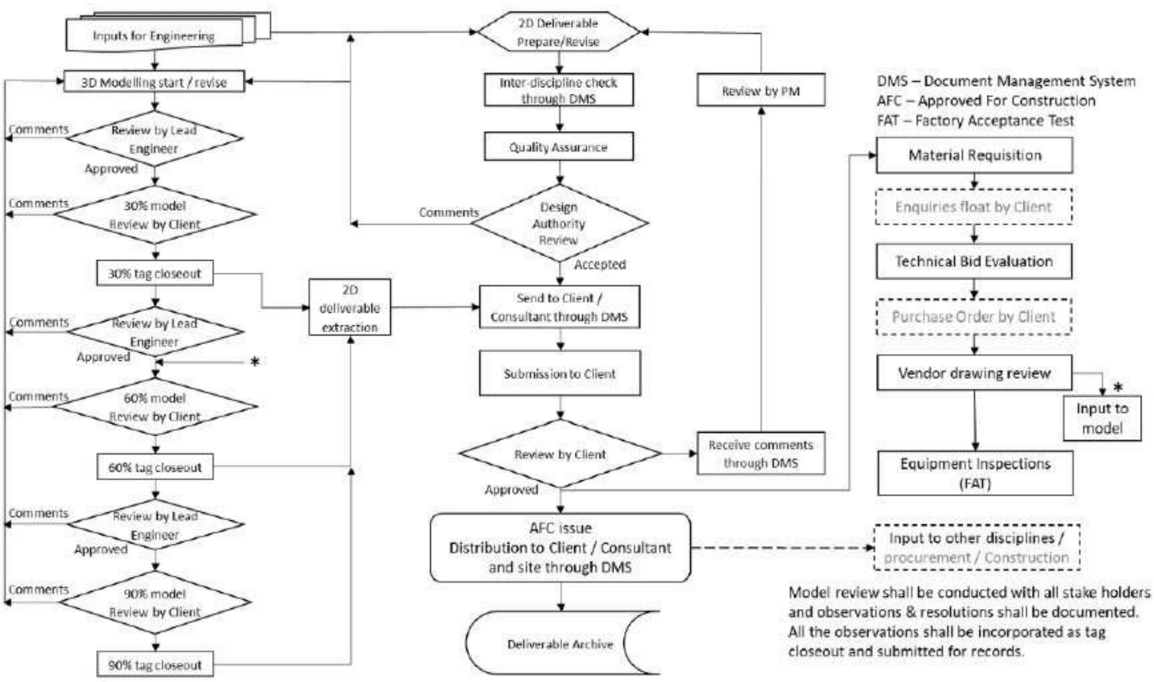
Topic details:

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

Smart Internz

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			
COMMAMD WIN	Ctrl+9	VERTICAL	VER			

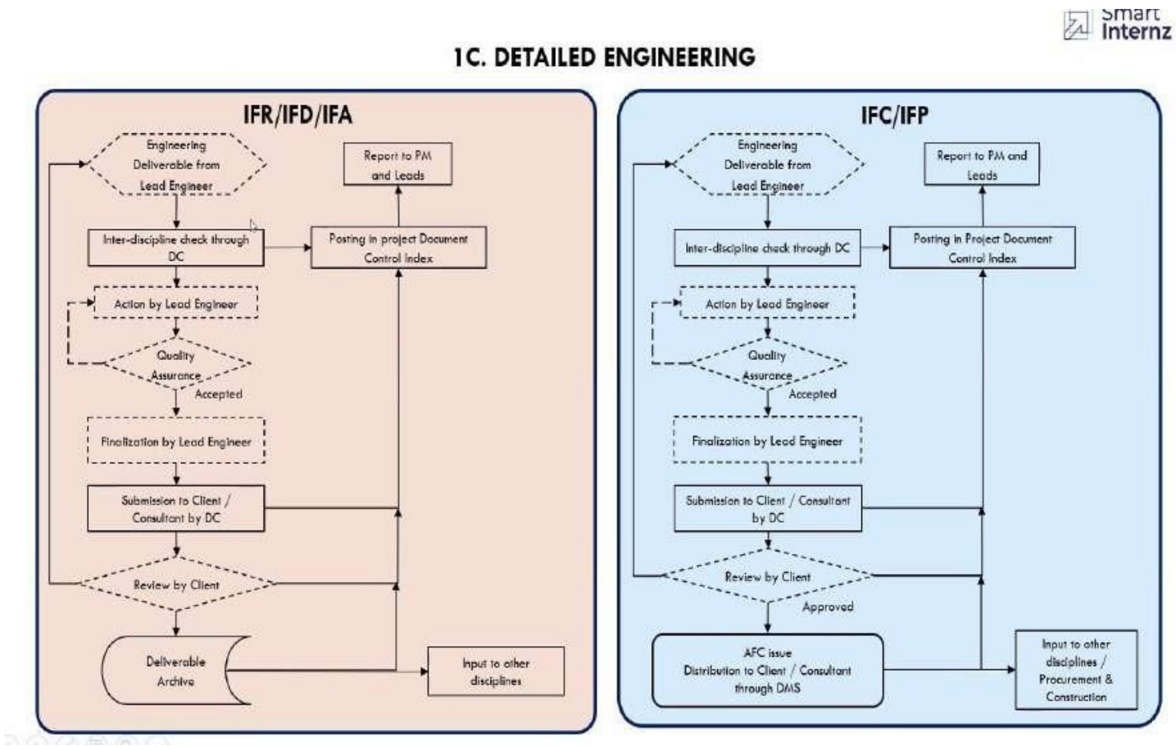
Topic details:

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

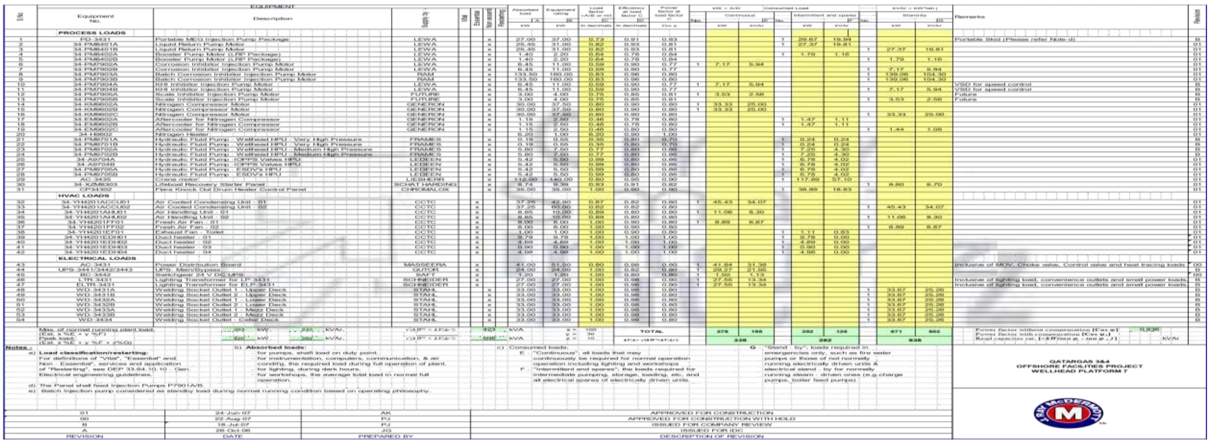
Topic details:



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

10th May2021: Engineering documentation for Typical diagrams

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



Topic details:

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

11th May2021: Classification of Transformers and Generators

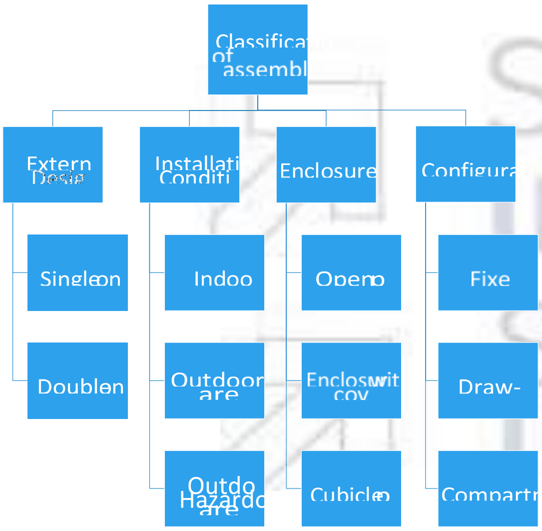
6	Classification of Transformers and Generators	Different types of Transformers	Different types of Generators

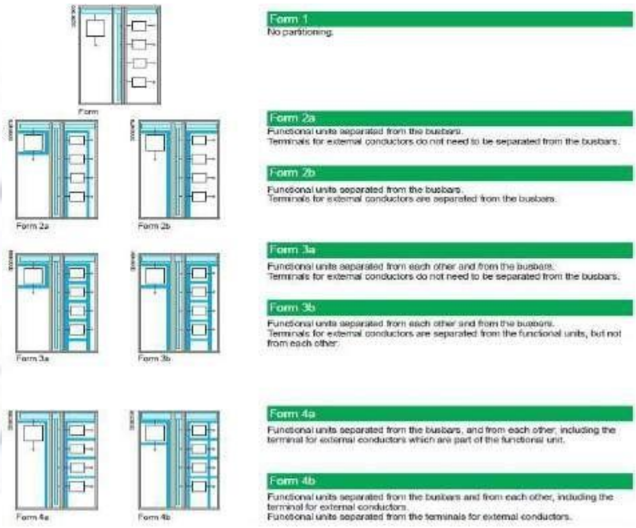
Topic details:

Classification of Transformers and Generators

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

7	Classification of Switchgare construction and power factor	Different types of Switchgare assembles	Power factor improvement
	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	Busduts of the system

110V or 220V DC UPS System

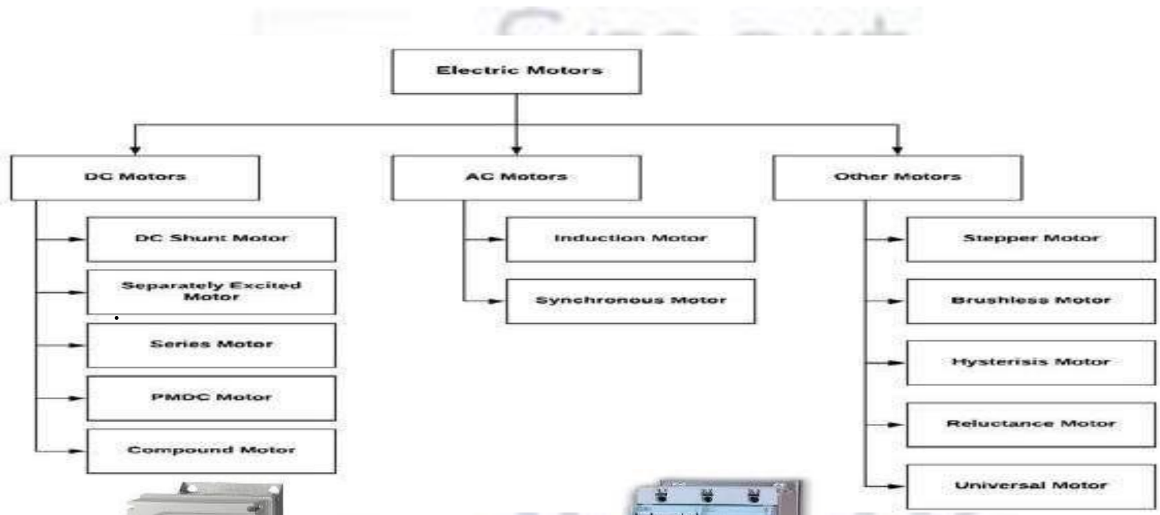
110V or 230V AC UPS System

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 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.

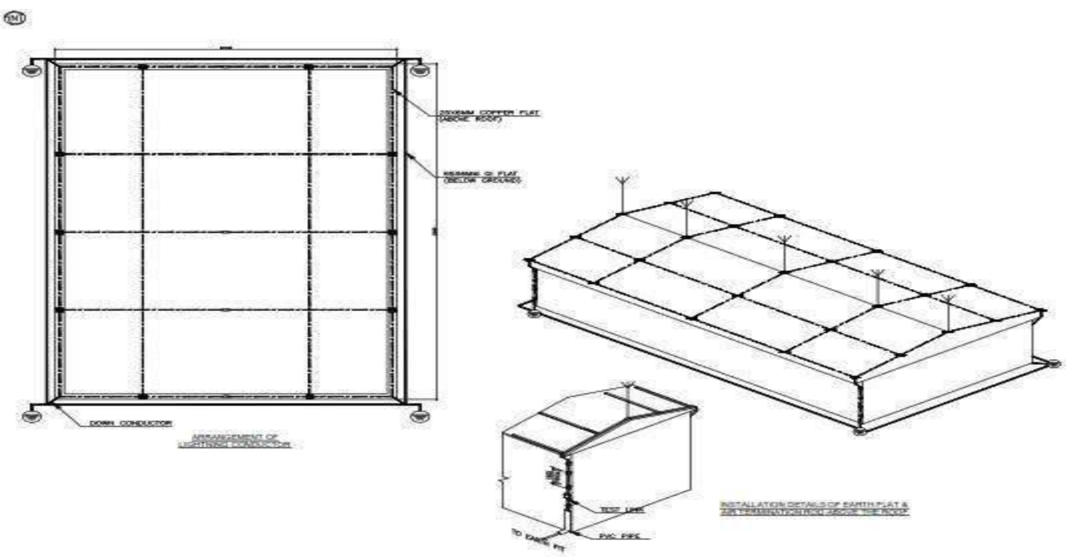
The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is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

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

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



Topic details: Discribing 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

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.

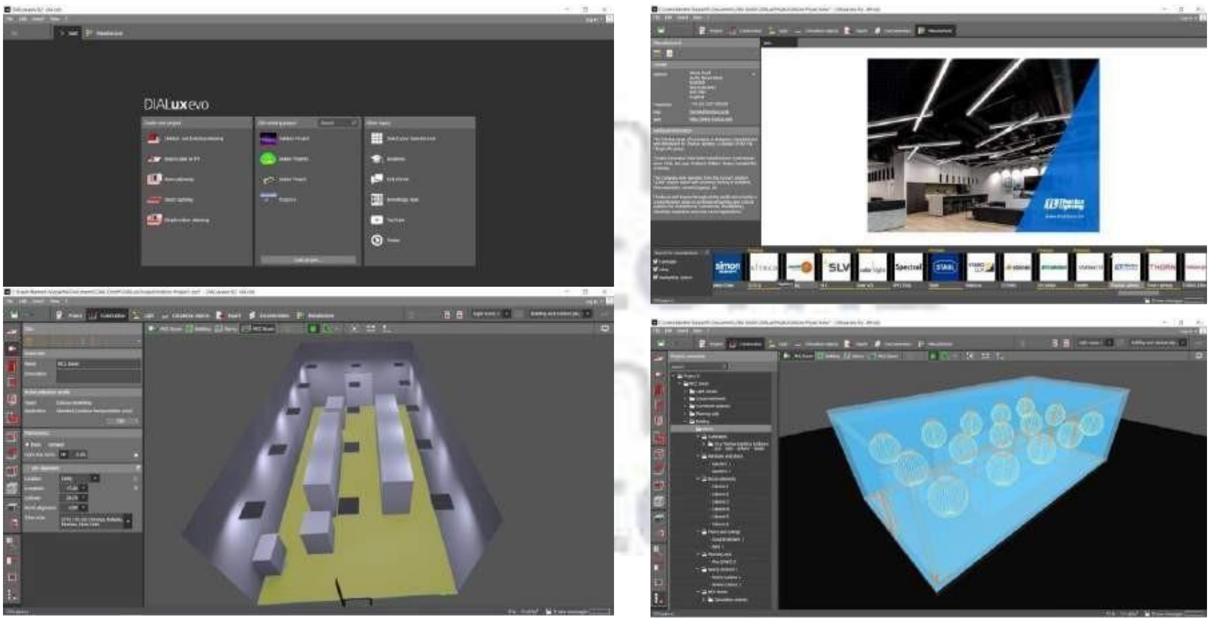
Types of light fittings: Industrial, flame proof type (EX d), increased safety type (Ex e).

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

12	Lighting or Illumination using DIALUX software	Lighting or illumination systems	Operation of dialux 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 claculations	Cabling calculations	Types of cabling materials

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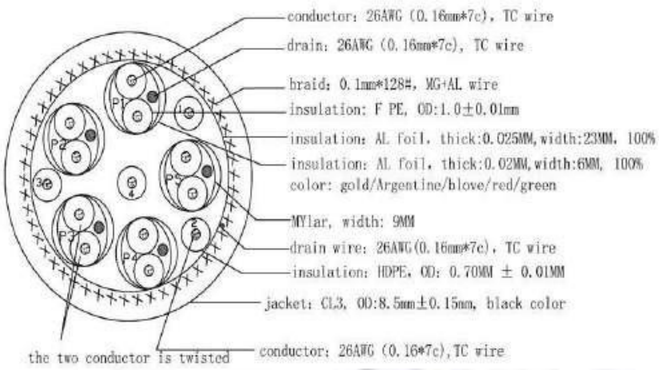
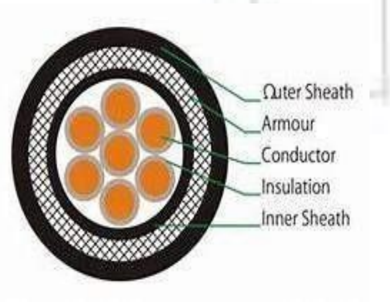
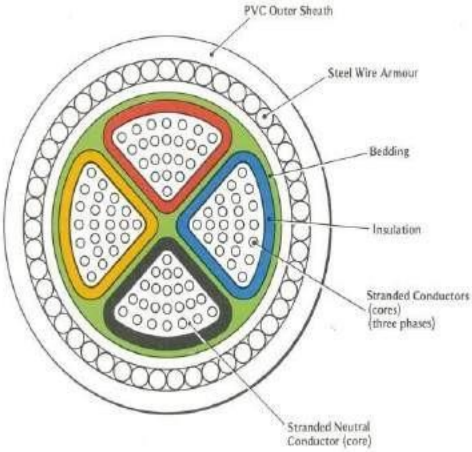
Topic details: Cabling and their types and claculations .







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 May2021: Cabling calculations and Cable gland selection.

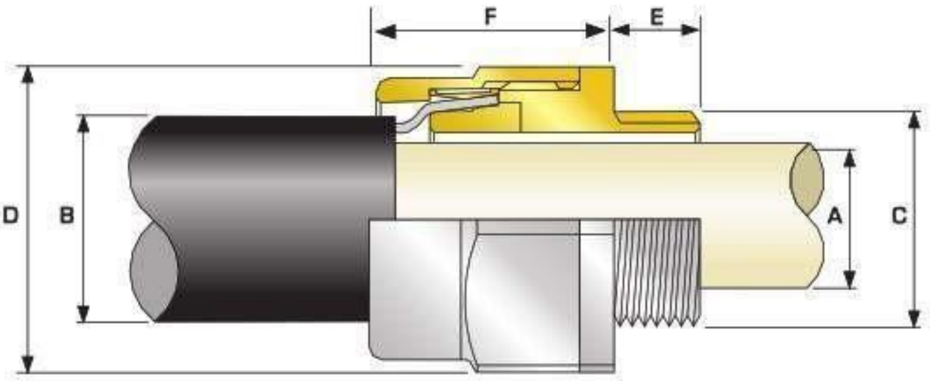
14	Cabling claculations and cable gland selection	Cabling calculations	Cable gland selection

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

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.

Sl. No.	Equipment No.	Equipment Description	Breaker Rating A	Breaker Type	Breaker No. of Poles	ELCB Rating mA	Absorbed Load [A] kW	Motor / Load Rating [B] kW	Load Factor [A] / [B] [C] decimal	Efficiency at Load Factor [C] [D] decimal	Power Factor at Load Factor [C] cos φ	Consumed Load: kW = [A] / [D]; kVAR = kW x tan φ — Continuous kW	Continuous kVAR	Intermittent kW	Intermittent kVAR	Stand-by kW	Stand-by kVAR	Remarks
1	PU2315	Silica filter feed pump					88.18	90.00	0.98	0.93	0.82	94.82	66.18					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					25.62	30.00	0.85	0.91	0.78	28.2	22.6					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					22.03	30.00	0.73	0.91	0.78					24.2	19.4	
4	PU2305	Feed Pump (Seperator)					89.06	90.00	0.99	0.93	0.82	95.8	66.8					
5	MX2305	MIXER (W)					89.75	90.00	1.00	0.93	0.73	96.5	90.4					
6	MX 2308	MIXER (S)					89.75	90.00	1.00	0.93	0.73					96.5	90.4	
7	BW2313	Blower					38.53	45.00	0.86	0.91	0.78	42.3	34.0					
8	Rotary valve	TK 2313B (I)					3.74	4.70	0.80	0.85	0.73			4.4	4.1			
9	SC2314	Screw conveyor (I)					8.65	9.20	0.94	0.85	0.73			10.18	9.53			
10	AG 2324A	Citric acid tan agitator (W)					6.50	7.50	0.87	0.85	0.73	7.65	7.16					
11	AG 2324B	Citric acid tank agitator (S)					6.50	7.50	0.87	0.85	0.73					7.6	7.2	
12	AG 2305	Citric oil rection vessol agitator					23.63	30.00	0.79	0.91	0.78	25.97	20.83					
13	AG 2309	Lye oil reaction vessel agitator					8.60	9.20	0.93	0.85	0.73	10.12	9.47					
14	AG 2310	Lye oil reaction vessel agitator					8.60	9.20	0.93	0.85	0.73	10.12	9.47					
15	AG 2314	Soap Adsorbant Tank Agitator					15.04	18.50	0.81	0.85	0.73	17.69	16.57					
	Maximum of normal running plant load : (Est. x%E + y%F)	433.5 kW			347.5 kVAR		sqrt (kW² +kVAR²) =	555.6 kVA			TOTAL	429.12	343.44	14.58	13.65	128.36	116.93	
	Peak Load : (Est. x%E + y%F + z%G)	446.3 kW			359.2 kVAR		sqrt (kW² +kVAR²) =	572.9 kVA			kVA	549.63		19.97		173.64		

Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <= 45	0.91	0.78
> 45 - < 150	0.93	0.82
>= 150	0.94	0.91

2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for contnious, intermittent and standby load.

T/F calculation:

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	429.12	343.4	549.63	— (i)
b. Intermittent load / Diversity Factor	14.58	13.7	19.97	— (ii)
c. Stand-by load required as consumed load	128.36	116.9	173.63	— (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	446.3	359.2	572.94	
Future expansion load (20% capacity)	89.3	71.8	114.59	
Total Load =	535.6	431.1	687.52	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load = 572.9 kVA
Spare capacity = 114.6 kVA
Required capacity = 687.5 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 :

P_T = 750 KVA (%Z)= 5.19 & Ratio X/R = 5.5

Hence, %R = = 0.937 %

%X = = 5.10 %

P_M = 90 KW having (K = 6 & C = 1 & Cos θ = 0.82 & Eff η = 0.93 & Cos Φs = 0.25

P_S = = 708.1039 KVA

Cos $θ_s$ = 0.25 ,Corresponding to Angle $θ_s$ = 75.52249 Degrees for which Sin $θ_s$ 0.97

P_B = 432.31 KVA & PB in KW is = 367.4635 & P_B in Kvar 229 Cos $θ_B$ = 0.850

Cos $θ_B$ = 0.85 ,Corresponding to Angle $θ_s$ = 31.78833 Degrees, for which Sin $θ_s$ = 0.53

P_{CP} = = 544.4895 KW
P_{CQ} = = 914.7386 KVAR
P_C = = 1064.526 KVA
Cos $θ_C$ = = 0.511485 , where as Sin $θ_C$ = 0.859

Voltage Regulation = = 6.9 %

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.

29th May2021: DG set calculations

16	DG set calculations

Topic details:

Transformer and DG set calculations,types ,sizing or selections

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.7553	Avg
	Efficiency	0.8873	Avg
	Total operating load on DG set in kVA at 0.7553 power factor	555.6	
	Largest motor to start in the sequence - load in KW	90	KW
	Running kVA of last motor (CosØ=0.91)	134	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)	806	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	421	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	421	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	1227	KVA
	Subtransient Reactance of Generator (Xd")	7.91%	(Assumed)
	Transient Reactance of Generator (Xd')	10.065%	(Assumed)
	Xd''' =(Xd"+Xd')/2	0.089875	
	Transient Voltage Dip	15%	(Max)
	Transient Voltage dip during Soft starter starting of Last motor P2 = Total momentary load in KVA x Xd" x (1-Transient Voltage Dip) / (Transient Voltage Dip)	625	KVA
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	1227	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) = Total momentary load in KVA / overcurrent capacity of DG (K)	818	KVA
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	421	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	625	KVA
	Overload capacity P3	818	KVA
	Considering the last value amongst P1, P2 and P3	818	KVA
	Hence, Existing Generator 818 KVA is adequate to cater the loads as per re-		
	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

Topic details:

Calculation of Earthing and Lighting protection calculations

		16				
	Location	Rajkot				
	Building	Concrete School				
	Type of Building	Triangle Roofs				
	Building Length (L)	12				
	Building breadth (W)	6				
	Building Height (H)	8				
	Risk Factor Calculation					
1	**Collection Area (A_c)**					
	A_c			=	(3.1415)×(c6^2)+2×(c6×c8)	
					644.3892	
2	**Probability of Being Struck (P)**					
	P			=	$A_c * N_g * 10^{-6}$	
					0.0007088828	
3	**Overall weighing factor**					
	a) Use of structure (A)			=	1.7	
	b) Type of construction (B)			=	1.0	
	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	
				=	0.867	
4	**Overall Risk Factor**		Po	=	P * Wo	
			Po	=	0.000614553	
			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)	
				=	36	Mts.
6	**Down Conductors**					
	Perimeter of building			=	36	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 conductors - 20mm X 2.5 mm Galvanized Steel Strip)					

Earthing calculation

	2	
Maximum line-to-ground fault in kA for 1 sec	18	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.010	
Average depth / length of Earth rod in meters	4.0	
Soil resistivity Ω-meter	9	
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		
$I_{lg} = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_o + T_m}{K_o + T_a}\right]}$		
αr - Thermal co-efficient of resistivity, at 20 oC	0.00320	
ρr - Resistivity of ground conductor at 20 oC	20.10	
Ta - Ambient Temperature is °C	50	
I_{l-g} - RMS fault current in kA = 50 KA	18	
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		
18 = Ac *	0.123	
Ac - Required conductor cross section in sq.mm	147	
Earth rod dia in mm	14	
Earth rod dia (including 25% corrosion allowance) in mm	17	
Earth flat sizing:		
Ac - Required conductor cross section in sq.mm		
$I_{lg} = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_o + T_m}{K_o + T_a}\right]}$		
αr - Thermal co-efficient of resistivity, at 20 oC	0.00320	
ρr - Resistivity of ground conductor at 20 oC	20.10	
Ta - Ambient Temperature is °C	50	
I_{l-g} - RMS fault current in kA = 50 KA	18	
tc - Short circuit current duration sec	1	

IEEE Std 80-2000 IEEE GUIDE FOR SAFETY

Table 1—Material constants

Description	Material conductivity (%)	α_r factor at 20 °C (1/°C)	K_o at 0 °C (0 °C)	Fusing[a] temperature T_m (°C)	ρ_r 20 °C (μΩ-cm)	TCAP thermal capacity [J/(cm[3]·°C)]
Copper, annealed soft-drawn	100.0	0.003 93	234	1083	1.72	3.42
Copper, commercial hard-drawn	97.0	0.003 81	242	1084	1.78	3.42
Copper-clad steel wire	40.0	0.003 78	245	1084	4.40	3.85
Copper-clad steel wire	30.0	0.003 78	245	1084	5.86	3.85
Copper-clad steel rod[b]	20.0	0.003 78	245	1084	8.62	3.85
Aluminum, EC grade	61.0	0.004 03	228	657	2.86	2.56
Aluminum, 5005 alloy	53.5	0.003 53	263	652	3.22	2.60
Aluminum, 6201 alloy	52.5	0.003 47	268	654	3.28	2.60
Aluminum-clad steel wire	20.3	0.003 60	258	657	8.48	3.58
Steel, 1020	10.8	0.001 60	605	1510	15.90	3.28
Stainless-clad steel rod[c]	9.8	0.001 60	605	1400	17.50	4.44
Zinc-coated steel rod	8.6	0.003 20	293	419	20.10	3.93
Stainless steel, 304	2.4	0.001 30	749	1400	72.00	4.03

[a]From ASTM standards.
[b]Copper-clad steel rods based on 0.254 mm (0.010 in) copper thickness.
[c]Stainless-clad steel rod based on 0.508 mm (0.020 in) No. 304 stainless steel thickness over No. 1020 steel core.

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:	
18 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	147
Earth flat area in mm	14
Earth flat area (including 25% corrosion allowance) in mm	17
Selected flat size W * Thk in sq mm	20

Rg - Grid resistance

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

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

ρ - Soil resistivity in Ω-meter=	9
L - Total buried length of ground conductor in meter	380
h - Depth of burial in meter	0.01
A - Grid area in sq. meter	8125
Rg - Grid resistance	0.068

Rr - Earth Electrode resistance

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

$$R_r = \frac{\rho}{2 \ x \ \pi \ x \ n_r \ x \ L_r} \left\{ l_n \left[\frac{4 \ x \ L_r}{b} \right] - 1 + \frac{2 \ x \ k_1 \ x \ L_r}{\sqrt{A}} \left(\sqrt{n_r} - 1 \right)^2 \right\}$$

ρ - Soil resistivity in Ω-meter, 16.96	9
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	4
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	8125
Rr - Earth Electrode resistance	3.5663

Grounding system resistance

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

ρ - Soil resistivity in Ω-meter, 16.96	9
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	4
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	8125
Rr - Earth Electrode resistance	3.5663

Grounding system resistance

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

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

R_m - Mutual ground resistance between the group of ground conductors, R_g and group of electrodes, R_r in Ω. Neglected R_m, since this is for homogenous soil

Rs - Total earthing system resistance	0.067	Ohms

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

Topic details:

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

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Motor Starting Current	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) (%)
3	LV MCC	PU2315	Silica filter feed pump	88.18	[illegible]	415	3	153.4	920.10	0.8	0.6	0.8	0.5	2	1	4.0	95	284	0.98	0.9	1	1	0.882	250.5	95	0.2470	0.0734	6.10	1.47
4	LV MCC	PU2322A	Soft water pump	25.62	[illegible]	415	3	44.6	267.33	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	95	0.9300	0.0816	5.81	1.40
5	LV MCC	PU 2314A	Absorbesnt/Neutral oil pump	22.03	[illegible]	415	3	38.3	229.87	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	4.88	1.18
6	LV MCC	PU2324	Citric Acid Tank pump	89.06	[illegible]	415	3	154.9	929.28	0.8	0.6	0.8	0.5	2	1	4.0	95	284	0.98	0.9	1	1	0.882	250.5	85	0.2470	0.0734	5.51	1.33
7	LV MCC	PU2333	Slop Oil pump	89.75	[illegible]	415	3	156.1	936.48	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	6.48	1.56
8	LV MCC	PU 2322B	Soft water pump-Stand by	89.75	[illegible]	415	3	156.1	936.48	0.8	0.6	0.8	0.5	2	1	4.0	95	284	0.98	0.9	1	1	0.882	250.5	105	0.2470	0.0734	6.86	1.65
9	LV MCC	PU2321A	Lye/Simplex Metering Pump	38.53	45.00	415	3	67.0	402.04	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1	0.882	130.5	100	0.6710	0.0794	6.78	1.63
10	LV MCC	PU2321B	Lye storage tank pump	3.74	4.70	415	3	6.5	39.02	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	100	5.9000	0.0947	5.38	1.30
11	LV MCC	PU2305	Feed Pump(Seperator)	8.65	9.20	415	3	15.0	90.26	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	6.26	1.51
12	LV MCC	PU2332	Saop Stock Pump	6.50	7.50	415	3	11.3	67.82	0.8	0.6	0.8	0.5	2	1	4.0	10	66	0.98	0.9	1	1	0.882	58.2	110	2.3400	0.0852	4.14	1.00
13	LV MCC	MX2305	Mixer	6.50	7.50	415	3	11.3	67.82	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	4.71	1.13
14	LV MCC	MX2308	Mixer	23.63	[illegible]	415	3	41.1	246.56	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	105	0.9300	0.0816	5.93	1.43
15	LV MCC	CF2312	Separator	8.60	9.20	415	3	15.0	89.74	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	85	0.9300	0.0816	1.75	0.42
16	LV MCC	BW2313	Blower	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	95	2.3400	0.0852	4.73	1.14
17	LV MCC	RV 2314	Rotary valve	15.04	18.50	415	3	26.2	156.93	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	5.66	1.36

Basis:

1. Overall derating factor k = k1 x k2 x k3 x k4
   - 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 ± 5%
5. Combined Effect of Voltage & Frequency Variation ±10%

LT CABLES

CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No.	Cable Route (From-To)	Type & Cable Size	Size of Cable (mm2)	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	95	1	33	33	4	4	
2	PU2322A	2	25	1	22	22	1.4	1.4	
3	PU 2314A	2	16	1	21	21	1	1	
4	PU2324	2	95	1	33	33	4	4	
5	PU2333	2	70	1	29	29	3.25	3.25	
6	PU 2322B	2	95	1	33	33	4	4	
7	PU2321A	2	35	1	24	24	1.8	1.8	
8	PU2321B	2	4	1	17	17	0.6	0.6	
9	PU2305	2	6	1	18	18	0.7	0.7	
10	PU2332	2	10	1	18	18	0.9	0.9	
11	MX2305	2	6	1	18	18	0.7	0.7	
12	MX2308	2	25	1	22	22	1.4	1.4	
13	CF2312	2	25	1	22	22	1.4	1.4	
14	BW2313	2	10	1	18	18	0.9	0.9	
15	RV 2314	2	10	1	18	18	0.9	0.9	
	Total			15		346	26.95	26.95	

Calculation			Result		
Maximum Cable Diameter:	33	mm	Selected Cable Tray width:	O.K	
Consider Spare Capacity of Cable Tray:	30%		Selected Cable Tray Depth:	O.K	
Distance between each Cable:	0	mm	Selectrd Cable Tray Weight:	O.K	Including Spare Capacity
Calculated Width of Cable Tray:	450	mm	Selected Cable Tray Size:	O.K	Including Spare Capacity
Calculated Area of Cable Tray:	14843	Sq.mm			
No of Layer of Cables in Cable Tray:	1		Required Cable Tray Size:	600 x 100	mm
Selected No of Cable Tray:	1	Nos.	Required Nos of Cable Tray:	1	No
Selected Cable Tray Width:	600	mm	Required Cable Tray Weight:	90.00	Kg/Meter/Tray
Selected Cable Tray Depth:	100	mm	Type of Cable Tray:	Ladder	
Selected Cable Tray Weight Capacity:	90	Kg/Meter			
Type of Cable Tray:	Ladder		Cable Tray Width Area Remar	25%	
Total Area of Cable Tray:	60000	Sq.mm	Cable Tray Area Remaning:	75%	

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

Sl. No.	Equipment No.	Equipment Description	Breaker Rating	Breaker Type	Breaker No. of Poles	ELCB Rating	Absorbed Load [A]	Motor / Load Rating [B]	Load Factor [A] / [B] [C]	Efficiency at Load Factor [C] [D]	Power Factor at Load Factor [C]	kW = [A] / [D] Continuous		Consumed Load Intermittent		kVAR = kW x tan ϕ Stand-by		Remarks
			A			mA	kW	kW	decimal	decimal	cos ϕ	kW	kVAR	kW	kVAR	kW	kVAR	
1	PU2315	Silica filter feed pump					88.18	90.00	0.98	0.93	0.82	94.82	66.18					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					25.62	30.00	0.85	0.91	0.78	28.2	22.6					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					22.03	30.00	0.73	0.91	0.78					24.2	19.4	
4	PU2305	Feed Pump (Seperator)					89.06	90.00	0.99	0.93	0.82	95.8	66.8					
5	MX2305	MIXER (W)					89.75	90.00	1.00	0.93	0.73	96.5	90.4					
6	MX 2308	MIXER (S)					89.75	90.00	1.00	0.93	0.73					96.5	90.4	
7	BW2313	Blower					38.53	45.00	0.86	0.91	0.78	42.3	34.0					
8	Rotary valve	TK 2313B (I)					3.74	4.70	0.80	0.85	0.73			4.4	4.1			
9	SC2314	Screw conveyor (I)					8.65	9.20	0.94	0.85	0.73			10.18	9.53			
10	AG 2324A	Citric acid tan agitator (W)					6.50	7.50	0.87	0.85	0.73	7.65	7.16					
11	AG 2324B	Citric acid tank agitator (S)					6.50	7.50	0.87	0.85	0.73					7.6	7.2	
12	AG 2305	Citric oil rection vessol agitator					23.63	30.00	0.79	0.91	0.78	25.97	20.83					
13	AG 2309	Lye oil reaction vessel agitator					8.60	9.20	0.93	0.85	0.73	10.12	9.47					
14	AG 2310	Lye oil reaction vessel agitator					8.60	9.20	0.93	0.85	0.73	10.12	9.47					
15	AG 2314	Soap Adsorbant Tank Agitator					15.04	18.50	0.81	0.85	0.73	17.69	16.57					

Maximum of normal running plant load : 433.5 kW 347.5 kVAR sqrt (kW² +kVAR²) = 555.6 kVA
(Est. x%E + y%F)

Peak Load : 446.3 kW 359.2 kVAR sqrt (kW² +kVAR²) = 572.9 kVA
(Est. x%E + y%F + z%G)

	Continuous kW	Continuous kVAR	Intermittent kW	Intermittent kVAR	Stand-by kW	Stand-by kVAR
TOTAL	429.12	343.44	14.58	13.65	128.36	116.93
kVA	549.63		19.97		173.64	

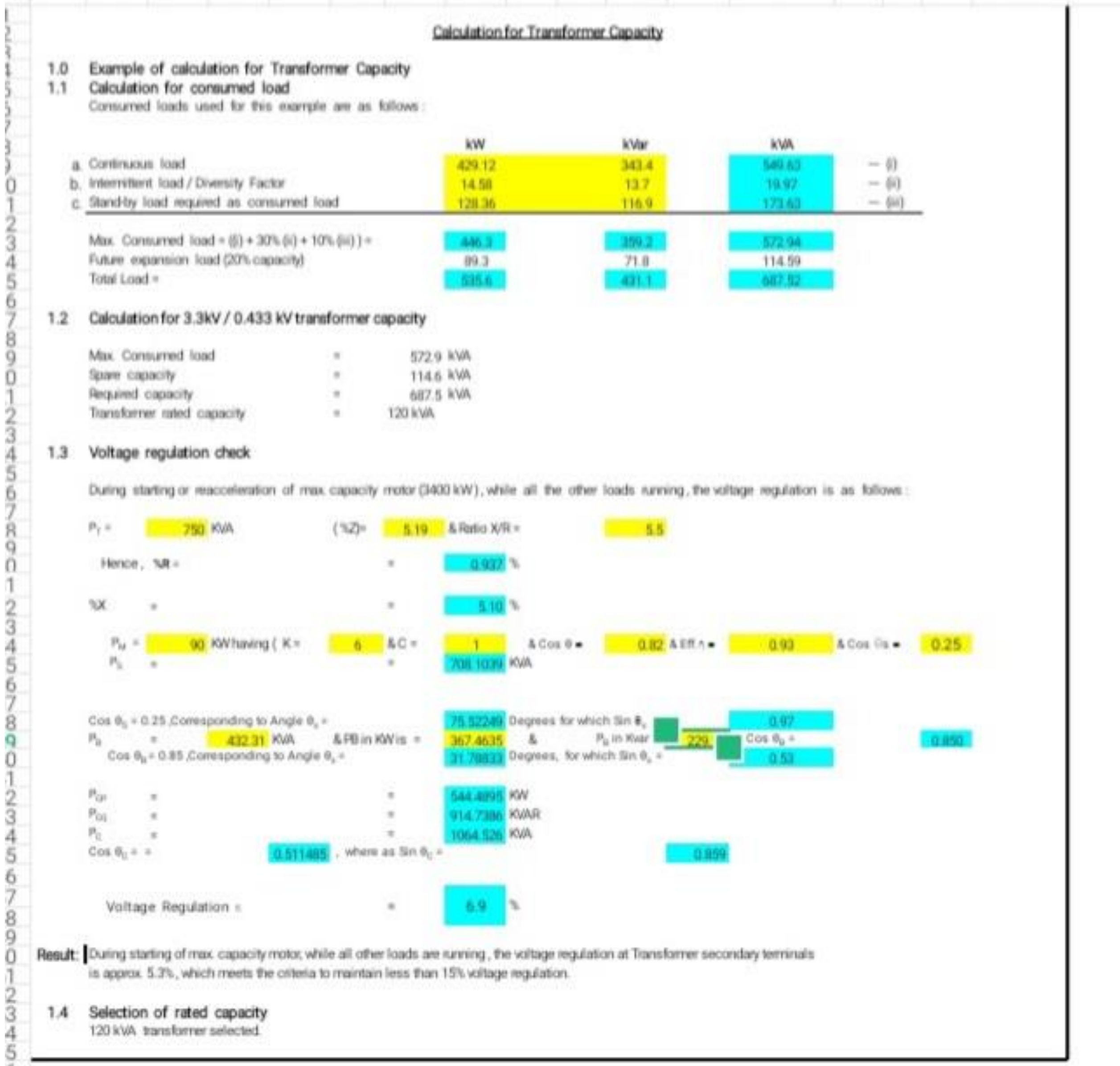
Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <= 45	0.91	0.78
> 45 - < 150	0.93	0.82
>= 150	0.94	0.91

2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for contnious, 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 :

	kW	kVar	kVA	
a. Continuous load	429.12	343.4	549.63	— (i)
b. Intermittent load / Diversity Factor	14.58	13.7	19.97	— (ii)
c. Stand-by load required as consumed load	128.36	116.9	173.63	— (iii)
Max. Consumed load = (i) + 30% (ii) + 10% (iii)) =	446.3	359.2	572.94	
Future expansion load (20% capacity)	89.3	71.8	114.59	
Total Load =	535.6	431.1	687.52	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	572.9 kVA
Spare capacity	=	114.6 kVA
Required capacity	=	687.5 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 :

P_T = 750 KVA (%Z)= 5.19 & Ratio X/R = 5.5

Hence, %R = = 0.937 %

%X = = 5.10 %

P_M = 90 KW having (K = 6 & C = 1 & Cos θ = 0.82 & Eff η = 0.93 & Cos θs = 0.25

P_S = = 708.1039 KVA

Cos θ_S = 0.25 ,Corresponding to Angle θ_s = 75.52249 Degrees for which Sin θ_s 0.97

P_B = 432.31 KVA & PB in KW is = 367.4635 & P_B in Kvar 229 Cos θ_B = 0.850

Cos θ_B = 0.85 ,Corresponding to Angle θ_s = 31.78833 Degrees, for which Sin θ_s = 0.53

P_{CP} = = 544.4895 KW

P_{CQ} = = 914.7386 KVAR

P_C = = 1064.526 KVA

Cos θ_C = = 0.511485 , where as Sin θ_C = 0.859

Voltage Regulation = = 6.9 %

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.

1.4 Selection of rated capacity

120 kVA transformer selected.

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.7553	Avg
	Efficiency	0.8873	Avg
	Total operating load on DG set in kVA at 0.7553 power factor	555.6	
	Largest motor to start in the sequence - load in KW	90	KW
	Running kVA of last motor (CosØ=0.91)	134	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)	806	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	421	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	421	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	1227	KVA
	Subtransient Reactance of Generator (Xd")	7.91%	(Assumed)
	Transient Reactance of Generator (Xd')	10.065%	(Assumed)
	Xd"' =(Xd"+Xd')/2	0.089875	
	Transient Voltage Dip	15%	(Max)
	Transient Voltage dip during Soft starter starting of Last motor P2 = Total momentary load in KVA x Xd" x (1-Transient Voltage Dip) / (Transient Voltage Dip)	625	KVA
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	1227	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) = Total momentary load in KVA / overcurrent capacity of DG (K)	818	KVA
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	421	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	625	KVA
	Overload capacity P3	818	KVA
	Considering the last value amongst P1, P2 and P3	818	KVA

Hence, Existing Generator 818 KVA is adequate to cater the loads as per re-

NOTE:VOLTAGE DIP CONSIDERED - 15%

Asssignment - 4

Eathing caluculation

2

		16			
	Location	Rajkot			
	Building	Concrete School			
	Type of Building	Triangle Roofs			
	Building Length (L)	12			
	Building breadth (W)	6			
	Building Height (H)	8			
	Risk Factor Calculation				
1	**Collection Area (A_c)**				
	A_c			=	(3.1415)×(c6^2)+2×(c6×c8)
					644.3892
2	**Probability of Being Struck (P)**				
	P			=	$A_c * N_g * 10^{-6}$
					0.000708828
3	**Overall weighing factor**				
	a) Use of structure (A)			=	1.7
	b) Type of construction (B)			=	1.0
	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
				=	0.867
4	**Overall Risk Factor**		Po	=	P * Wo
			Po	=	0.000614553
			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)
				=	36 Mts.
6	**Down Conductors**				
	Perimeter of building			=	36 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 conductors - 20mm X 2.5 mm Galvanized Steel Strip)				

Assignment -5

Lightning protection

	2	
Maximum line-to-ground fault in kA for 1 sec	18	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.010	
Average depth / length of Earth rod in meters	4.0	
Soil resistivity Ω-meter	9	
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

$$I_{lg} = A_c X \sqrt{\left[\frac{TCAPx10^{-4}}{t_c X \alpha_r X \rho_r}\right] x l_n \left[\frac{K_0 + T_m}{K_0 + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.00320
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
I_{l-g} - RMS fault current in kA = 50 KA	18
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
K0 - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod	
18 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	147
Earth rod dia in mm	14
Earth rod dia (including 25% corrosion allowance) in mm	17

Earth flat sizing:

Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c X \sqrt{\left[\frac{TCAPx10^{-4}}{t_c X \alpha_r X \rho_r}\right] x l_n \left[\frac{K_0 + T_m}{K_0 + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.00320
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
I_{l-g} - RMS fault current in kA = 50 KA	18
tc - Short circuit current duration sec	1

IEEE
Std 80-2000

IEEE GUIDE FOR SAFETY

Table 1—Material constants

Description	Material conductivity (%)	α_r factor at 20 °C (1/°C)	K_o at 0 °C (0 °C)	Fusing[a] temperature T_m (°C)	ρ_r 20 °C (μΩ·cm)	TCAP thermal capacity [J/(cm³·°C)]
Copper, annealed soft-drawn	100.0	0.003 93	234	1083	1.72	3.42
Copper, commercial hard-drawn	97.0	0.003 81	242	1084	1.78	3.42
Copper-clad steel wire	40.0	0.003 78	245	1084	4.40	3.85
Copper-clad steel wire	30.0	0.003 78	245	1084	5.86	3.85
Copper-clad steel rod[b]	20.0	0.003 78	245	1084	8.62	3.85
Aluminum, EC grade	61.0	0.004 03	228	657	2.86	2.56
Aluminum, 5005 alloy	53.5	0.003 53	263	652	3.22	2.60
Aluminum, 6201 alloy	52.5	0.003 47	268	654	3.28	2.60
Aluminum-clad steel wire	20.3	0.003 60	258	657	8.48	3.58
Steel, 1020	10.8	0.001 60	605	1510	15.90	3.28
Stainless-clad steel rod[c]	9.8	0.001 60	605	1400	17.50	4.44
Zinc-coated steel rod	8.6	0.003 20	293	419	20.10	3.93
Stainless steel, 304	2.4	0.001 30	749	1400	72.00	4.03

[a]From ASTM standards.
[b]Copper-clad steel rods based on 0.254 mm (0.010 in) copper thickness.
[c]Stainless-clad steel rod based on 0.508 mm (0.020 in) No. 304 stainless steel thickness over No. 1020 steel core.

ρ - Soil resistivity in Ω-meter, 16.96	9
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	4
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	8125
Rr - Earth Electrode resistance	3.5663

Grounding system resistance

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

$$\boxed{R_s = \frac{R_g \text{ x } R_2 - R_m^{\ 2}}{R_g + R_2 - 2R_m}}$$

R_m - Mutual ground resistance between the group of ground conductors, R_g and group of electrodes, R_r in Ω. Neglected R_m, since this is for homogenous soil

Rs - Total earthing system resistance	0.067	Ohms

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

Assig

ment - 6

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	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) (%)
3	LV MCC	PU2315	Silica filter feed pump	88.18	90.00	415	3	153.4	920.10	0.8	0.6	0.8	0.5	2	1	4.0	95	284	0.98	0.9	1	1	0.882	250.5	95	0.2470	0.0734	6.10	1.47
4	LV MCC	PU2322A	Soft water pump	25.62	30.00	415	3	44.6	267.33	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	95	0.9300	0.0816	5.81	1.40
5	LV MCC	PU 2314A	Absorbesnt/Neutral oil pump	22.03	30.00	415	3	38.3	229.87	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	4.88	1.18
6	LV MCC	PU2324	Citric Acid Tank pump	89.06	90.00	415	3	154.9	929.28	0.8	0.6	0.8	0.5	2	1	4.0	95	284	0.98	0.9	1	1	0.882	250.5	85	0.2470	0.0734	5.51	1.33
7	LV MCC	PU2333	Slop Oil pump	89.75	90.00	415	3	156.1	936.48	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	6.48	1.56
8	LV MCC	PU 2322B	Soft water pump-Stand by	89.75	90.00	415	3	156.1	936.48	0.8	0.6	0.8	0.5	2	1	4.0	95	284	0.98	0.9	1	1	0.882	250.5	105	0.2470	0.0734	6.86	1.65
9	LV MCC	PU2321A	Lye/Simplex Metering Pump	38.53	45.00	415	3	67.0	402.04	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1	0.882	130.5	100	0.6710	0.0794	6.78	1.63
10	LV MCC	PU2321B	Lye storage tank pump	3.74	4.70	415	3	6.5	39.02	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	100	5.9000	0.0947	5.38	1.30
11	LV MCC	PU2305	Feed Pump(Seperator)	8.65	9.20	415	3	15.0	90.26	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	6.26	1.51
12	LV MCC	PU2332	Saop Stock Pump	6.50	7.50	415	3	11.3	67.82	0.8	0.6	0.8	0.5	2	1	4.0	10	66	0.98	0.9	1	1	0.882	58.2	110	2.3400	0.0852	4.14	1.00
13	LV MCC	MX2305	Mixer	6.50	7.50	415	3	11.3	67.82	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	4.71	1.13
14	LV MCC	MX2308	Mixer	23.63	30.00	415	3	41.1	246.56	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	105	0.9300	0.0816	5.93	1.43
15	LV MCC	CF2312	Separator	8.60	9.20	415	3	15.0	89.74	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	85	0.9300	0.0816	1.75	0.42
16	LV MCC	BW2313	Blower	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	95	2.3400	0.0852	4.73	1.14
17	LV MCC	RV 2314	Rotary valve	15.04	18.50	415	3	26.2	156.93	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	5.66	1.36

Basis:

1. Overall derating factor k = k1 x k2 x k3 x k4

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 ± 5%

5. Combined Effect of Voltage & Frequency Variation ±10%

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 (mm2)	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	95	1	33	33	4	4	
2	PU2322A	2	25	1	22	22	1.4	1.4	
3	PU 2314A	2	16	1	21	21	1	1	
4	PU2324	2	95	1	33	33	4	4	
5	PU2333	2	70	1	29	29	3.25	3.25	
6	PU 2322B	2	95	1	33	33	4	4	
7	PU2321A	2	35	1	24	24	1.8	1.8	
8	PU2321B	2	4	1	17	17	0.6	0.6	
9	PU2305	2	6	1	18	18	0.7	0.7	
10	PU2332	2	10	1	18	18	0.9	0.9	
11	MX2305	2	6	1	18	18	0.7	0.7	
12	MX2308	2	25	1	22	22	1.4	1.4	
13	CF2312	2	25	1	22	22	1.4	1.4	
14	BW2313	2	10	1	18	18	0.9	0.9	
15	RV 2314	2	10	1	18	18	0.9	0.9	
Total				15		346	26.95	26.95	

Calculation			Result		
Maximum Cable Diameter:	33	mm	Selected Cable Tray width:	O.K	
Consider Spare Capacity of Cable Tray:	30%		Selected Cable Tray Depth:	O.K	
Distance between each Cable:	0	mm	Selectrd Cable Tray Weight:	O.K	Including Spare Capacity
Calculated Width of Cable Tray:	450	mm	Selected Cable Tray Size:	O.K	Including Spare Capacity
Calculated Area of Cable Tray:	14843	Sq.mm			
No of Layer of Cables in Cable Tray:	1		Required Cable Tray Size:	600 x 100	mm
Selected No of Cable Tray:	1	Nos.	Required Nos of Cable Tray:	1	No
Selected Cable Tray Width:	600	mm	Required Cable Tray Weight:	90.00	Kg/Meter/Tray
Selected Cable Tray Depth:	100	mm	Type of Cable Tray:	Ladder	
Selected Cable Tray Weight Capacity:	90	Kg/Meter			
Type of Cable Tray:	Ladder		Cable Tray Width Area Remar	25%	
Total Area of Cable Tray:	60000	Sq.mm	Cable Tray Area Remaning:	75%	