Internship Program Report

By

V.SHANMUKHA SRIVALLI-19485A0237

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

NATIONAL BOARD of ACCREDITATION

Counselling Code : GDLV

In association with

Smart Internz

Contents

Introduction

Internship program arranged by GUDLAVALLERU ENGINEERING COLLEGEin association with Smart Internz, Hyderabad for the benefit of 3rdyear 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. SrinivasaRao–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

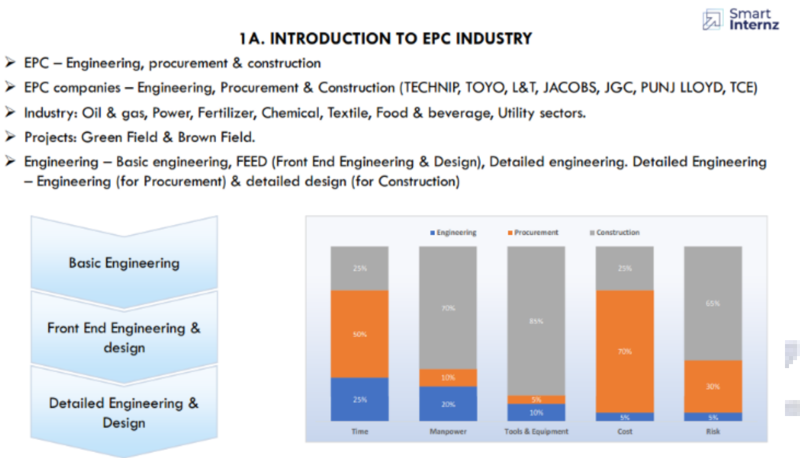
Presenter: Mr Ramesh V

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

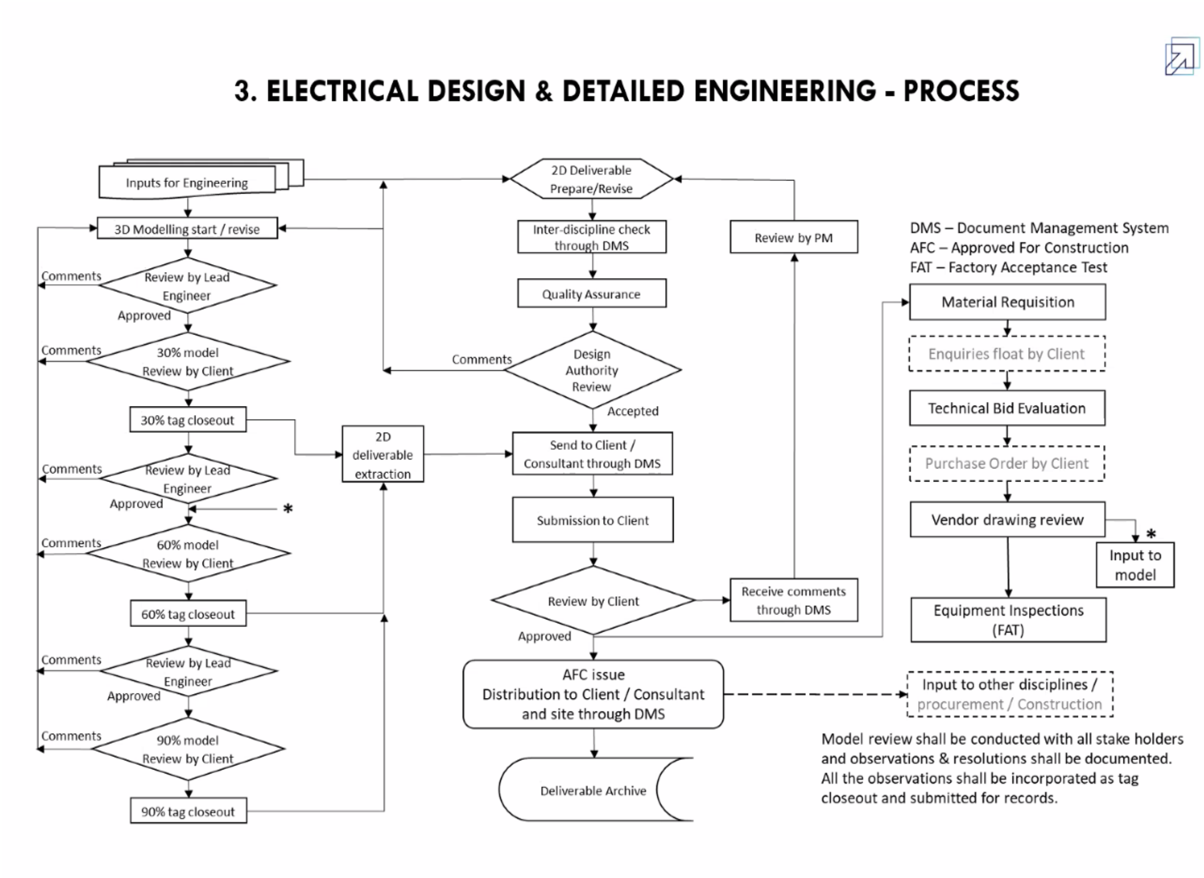


Topic details:

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



Topic details:

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

5 th May2021: Engineering documentation for commands and formulae

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

3C. AUTOCAD BASIC COMMANDS

AUTOCAD BASIC KEYS

STANDARD		DRAW		MODIFY		FORMAT	
NEW	Ctrl+N	LINE	L	ERASE	E	PROPERTIES	MO
OPEN	Ctrl+O	RAY	RAY	COPY	CO	SELECT COLOR	COL
SAVE	Ctrl+S	PLINE	PL	MIRROR	MI	LAYER	LA
PLOT	Ctrl+P	3DPOLY	3P	OFFSET	O	LINETYPE	LT
PLOT PREVIEW	PRE	POLIGONE	POL	ARRAY	AR	LINEWEIGHTS	LW
CUT	Ctrl+X	RECTANGLE	REC	MOVE	M	LT SCALE	LTS
COPY	Ctrl+C	ARC	A	ROTATE	RO	LIST	LI
PASTE	Ctrl+V	CIRCLE	C	SCALE	SC	DIMEN. STYLE	D
MATCH PROPE.	MA	SPLINE	SPL	STRECH	S	RENAME	REN
CLOSE	Ctrl+F4	ELLIPSE	EL	TRIM	TR	OPTION	OP
EXIT	Ctrl+Q	BLOCK	B	EXTENED	EX		
		POINT	PO	BRAKE	BR		
		HATCH	H	CHAMFER	CHA		
		GRADIENT	GD	FILLET	F		
		REGION	REG	EXPLODE	X		
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EXTRA				DRAFTING		PAPER SIZE
UNIT	UN	UCS	UCS	ORTHO	F8, Ctrl+L	A4=210*297
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(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			

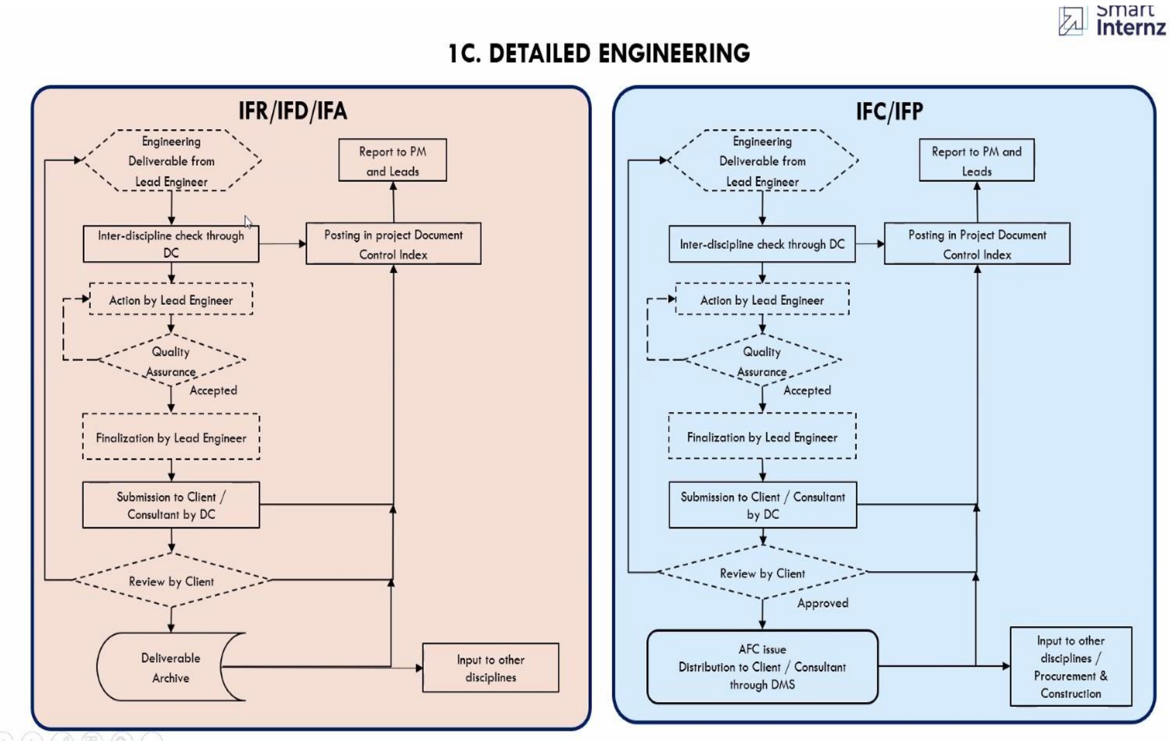
Topic details:

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

7th 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

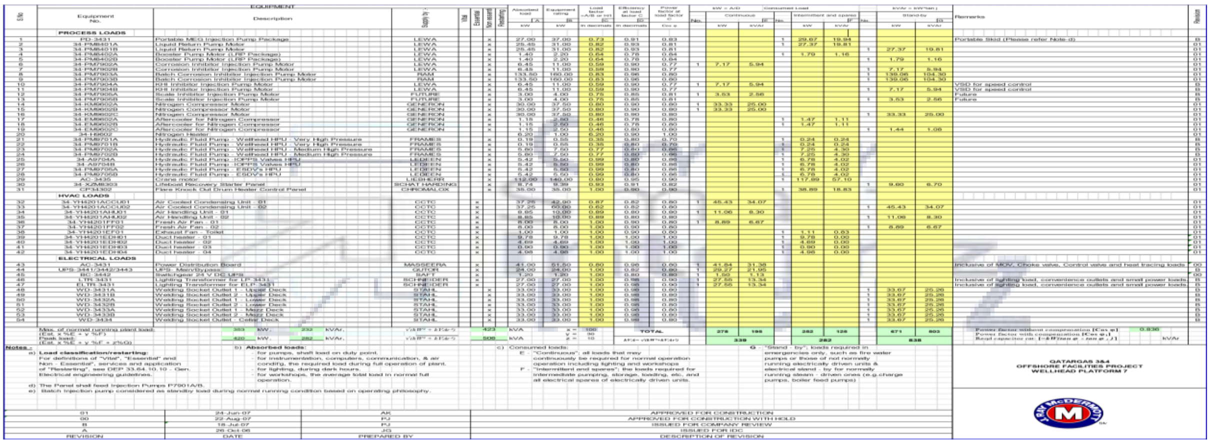
Topic details:



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

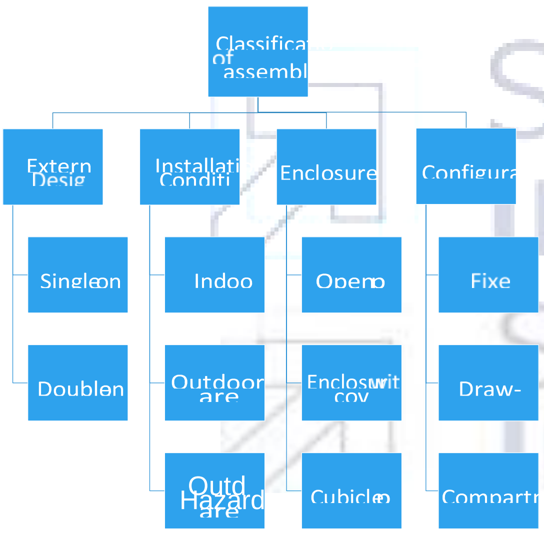
6	Classification of Transformers and Generators	Different types of Transformers	Different types of Generators

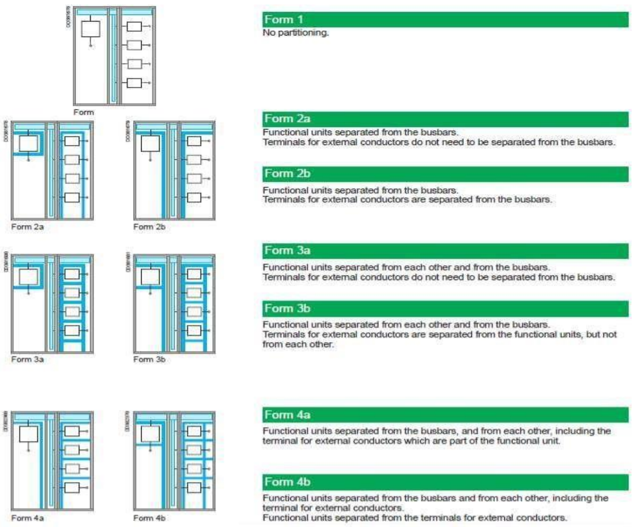
Topic details:

Classification of Transformers and Generators

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

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





Topic details:

Classification of Switchgarecontruction and Power FactorImprovement

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

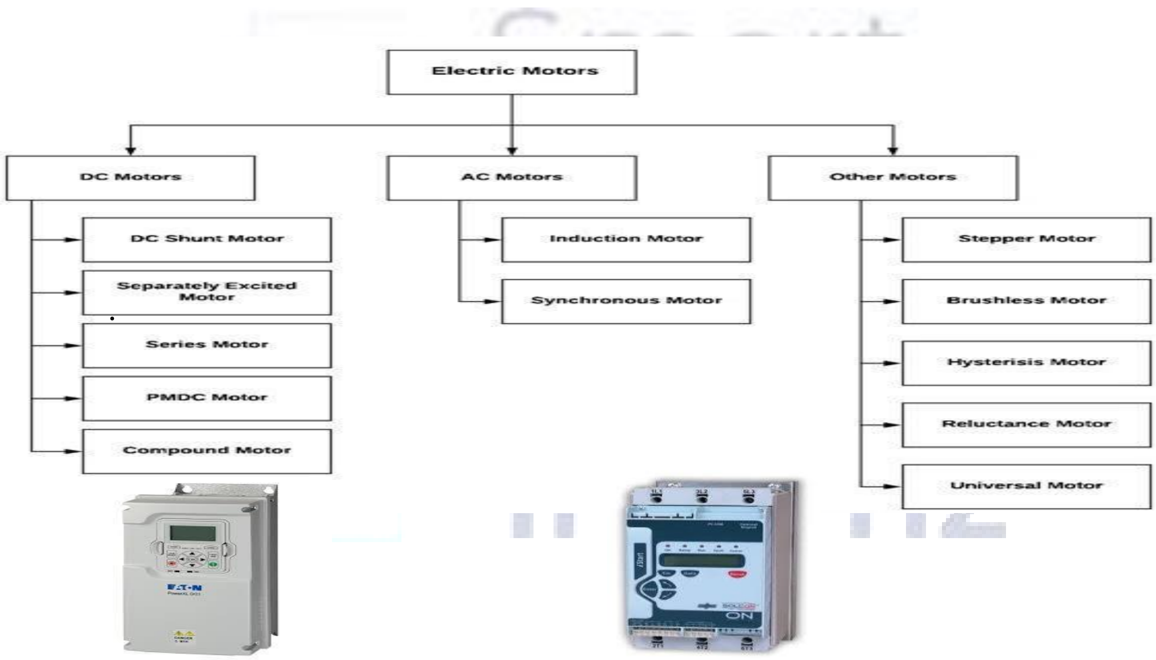
110V or 230V AC UPS System

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



Topicdetails: Detailing about Motor Starter and Sizing of motors and theirselection.

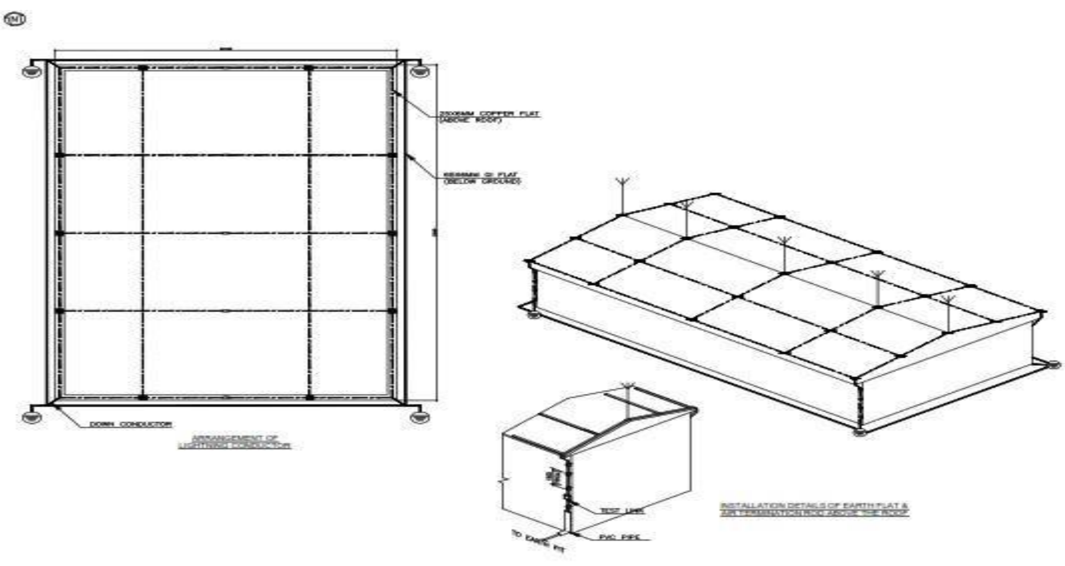
The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is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

Different types of motor starters are as follows:

- Direct-On-LineStarter
- Rotor ResistanceStarter
- Stator ResistanceStarter
- Auto TransformerStarter

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

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



Topicdetails: Discribing about Earthing system and LightingProtection.

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 andcalculations.

11	Lighting or Illumination systems and Calculations	Lighting or illumination systems	Lighting calculations

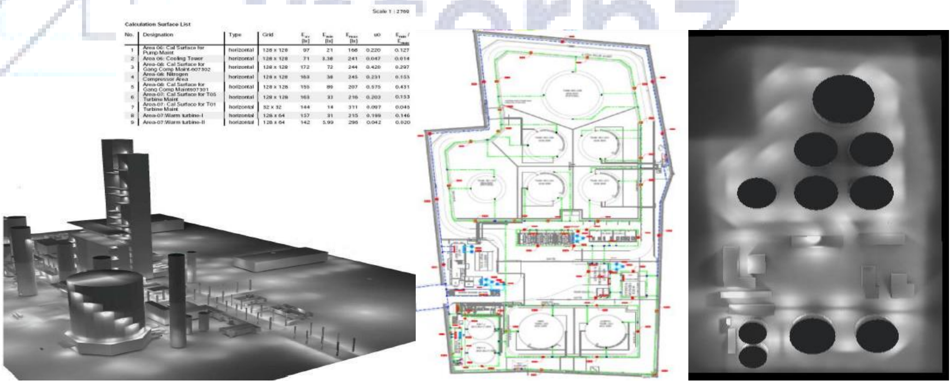
Topic details: Lighting or Illumination systems andCalculations.

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 orconduits.

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.

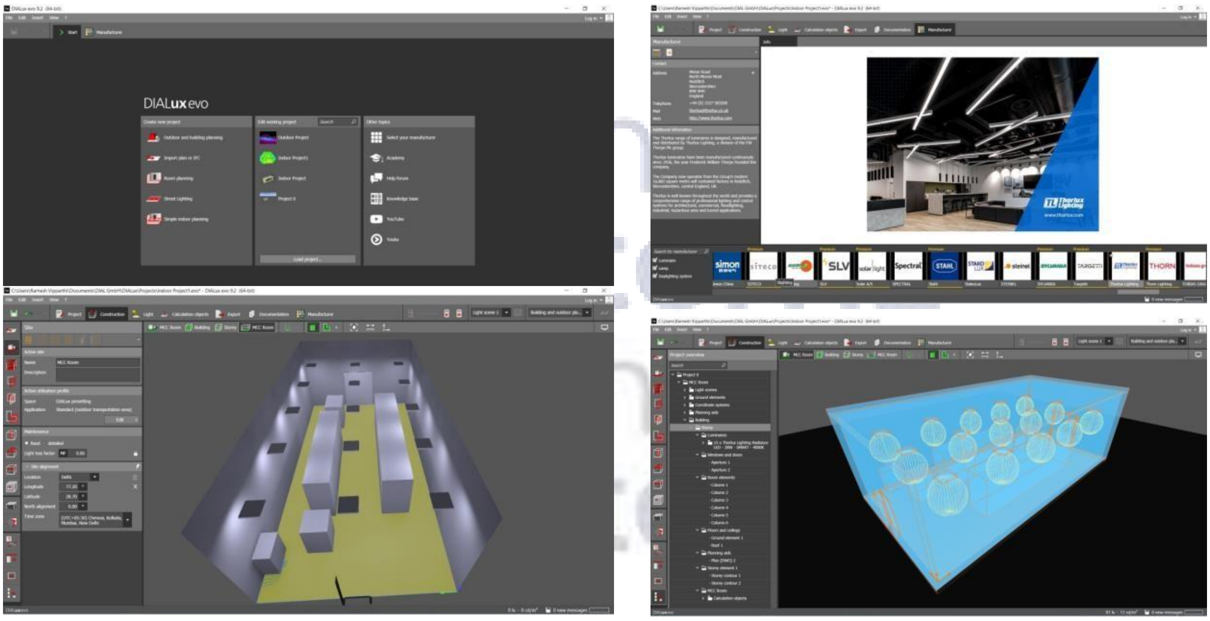
Types of light fittings: Industrial, flame proof type (EX d), increased safety type (Ex e).

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

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

Topicdetails: Lighting or Illumination Calculations using DIALUXsoftware.

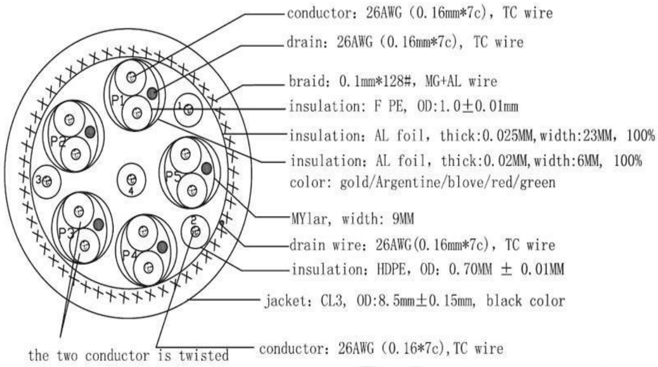
Here we are using this Dialuxevo 5.9.2 software windows to construct the power plant and we can perform the operation from this software.

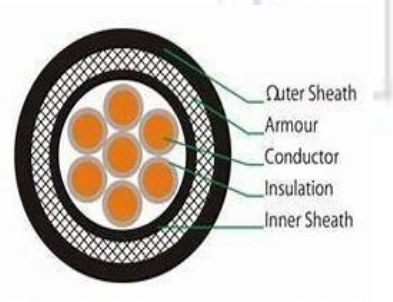


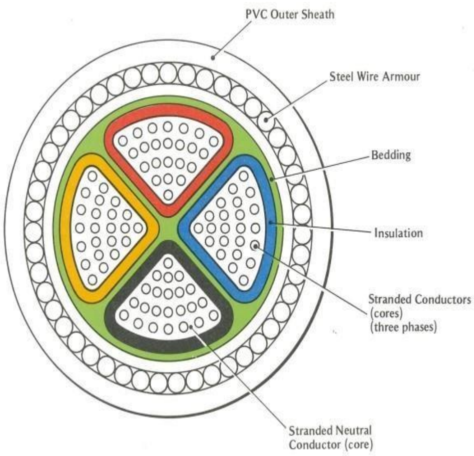
24th May2021: Cabling and their calculations and types.

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

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.

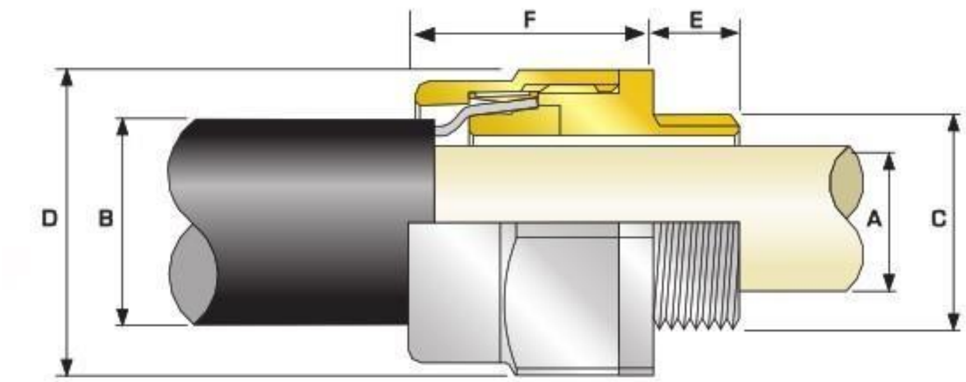
14	Cabling claculations and cable gland selection	Cabling calculations	Cable gland selection

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

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] (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)	Continuous kW	Continuous kVAR	Intermittent kW	Intermittent kVAR	Stand-by kW	Stand-by kVAR	Remarks
1	PU2315	Silica filter feed pump					66.68	75.00	0.89	0.93	0.82	71.70	50.05					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					19.37	22.00	0.88	0.91	0.78	21.3	17.1					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					16.66	18.50	0.90	0.91	0.78					18.3	14.7	
4	PU2305	Feed Pump (Seperator)					67.34	75.00	0.90	0.93	0.82	72.4	50.5					
5	MX2305	MIXER (W)					67.86	75.00	0.90	0.93	0.82	73.0	50.9					
6	MX 2308	MIXER (S)					67.86	75.00	0.90	0.93	0.82					73.0	50.9	
7	BW2313	Blower					29.13	37.00	0.79	0.91	0.78	32.0	25.7					
8	Rotary valve	TK 2313B (I)					2.83	3.70	0.76	0.85	0.73			3.3	3.1			
9	SC2314	Screw conveyor (I)					6.54	7.50	0.87	0.85	0.73			7.69	7.20			
10	AG 2324A	Citric acid tan agitator (W)					4.91	7.50	0.65	0.85	0.73	5.78	5.41					
11	AG 2324B	Citric acid tank agitator (S)					4.91	7.50	0.65	0.85	0.73					5.8	5.4	
12	AG 2305	Citric oil rection vessol agitator					17.87	22.00	0.81	0.91	0.78	19.64	15.75					
13	AG 2309	Lye oil reaction vessel agitator					6.50	9.20	0.71	0.85	0.73	7.65	7.16					
14	AG 2310	Lye oil reaction vessel agitator					6.50	9.20	0.71	0.85	0.73	7.65	7.16					
15	AG 2314	Soap Adsorbant Tank Agitator					11.37	15.00	0.76	0.85	0.73	13.38	12.52					
											TOTAL	324.46	242.28	11.02	10.32	97.05	71.03	
											kVA	404.94		15.10		120.27		

Column group headings: kW = [A] / [D]; Consumed Load; kVAR = kW x tan φ

Maximum of normal running plant load : (Est. x%E + y%F) 327.8 kW 245.4 kVAR sqrt (kW² +kVAR²) = 409.4 kVA

Peak Load : (Est. x%E + y%F + z%G) 337.5 kW 252.5 kVAR sqrt (kW² +kVAR²) = 421.5 kVA

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:

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	324.46	242.3	404.94	--- (i)
b. Intermittent load / Diversity Factor	11.2	10.3	15.23	--- (ii)
c. Stand-by load required as consumed load	97.5	71.0	120.63	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	337.6	252.5	421.54	
Future expansion load (20% capacity)	67.5	50.5	84.31	
Total Load =	405.1	303.0	505.85	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load = 421.5 kVA
Spare capacity = 84.3 kVA
Required capacity = 505.9 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 = 409.4 KVA (%Z)= 4 & Ratio X/R = 3.3

Hence , %R = = 1.176 %

%X = = 3.82 %

P_M = 75 KW having (K = 6 & C = 1 & Cos θ = 0.81 & Eff.η = 0.89 & Cos θs = 0.25

P_S = = 624.22 KVA

Cos $θ_S$ = 0.25 ,Corresponding to Angle $θ_s$ = 75.5225 Degrees for which Sin $θ_s$ = 0.97

P_B = 421.5 KVA & PB in KW is = 358.275 & P_B in Kvar = 252.5 ∴ Cos $θ_B$ = 0.850

Cos $θ_B$ = 0.85 ,Corresponding to Angle $θ_s$ = 31.7883 Degrees, for which Sin $θ_s$ = 0.53

P_{CP} = = 514.33 KW
P_{CQ} = = 856.898 KVAR
P_C = = 999.405 KVA
Cos $θ_C$ = = 0.51464 , where as Sin $θ_C$ = 0.857

Voltage Regulation ε = 9.5 %

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

Assignment - 3

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (Cosø)	0.77	Avg
	Efficiency	0.89	Avg
	Total operating load on DG set in kVA at 0.77 power factor	**409.4**	
	Largest motor to start in the sequence - load in KW	75	KW
	Running kVA of last motor (Cosø= 0.91)	109	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)	**657**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**300**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**300**	**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	957	KVA
	Subtransient Reactance of Generator (Xd")	7.91%	(Assumed)
	Transient Reactance of Generator (Xd')	10.065%	(Assumed)
	Xd'" =(Xd"+Xd')/2	0.089675	
	Transient Voltage Dip		
	Transient Voltage dip during Soft starter starting of Last motor	15%	(Max)
	P2 = Total momentary load in KVA x Xd'" x (1-Transient Voltage Dip) (Transient Voltage Dip)	FALSE	KVA
	Overload capacity P3		
	Capacity of DG set required considering overload capacity Total momentary load in KVA		
	overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)		
C	Capacity of DG set required considering overload capacity (P3) = <u>Total momentary load in KVA</u> overcurrent capacity of DG (K)		
	Considering the last value amongst P1, P2 and P3	957	KVA
	Continous operation under load -P1	150%	
	Transient Voltage dip during Soft starter starting of Last motor P2 Overload capacity P3		
	Considering the last value amongst P1, P2 and P3	638	KVA
		300	KVA
		FALSE	KVA
		638	KVA
		638	KVA

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

Assignment -5

Lightning protection

		14
Location		Delhi
Building		Srtuctural, Industrial
Type of Building		Triangle Roofs (c)
Building Length (L)		11
Building breadth (W)		7
Building Height (H)		5

Risk Factor Calculation

1 Collection Area (A_c)

A_c = 3.14*h*h +2(h*l)
188.5

2 Probability of Being Struck (P)

P = A_c * N_g * 10^{-6}
0.00035815

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 * B * C * D * E
	Wo	=	0.096

4 Overall Risk Factor

Po	=	P * Wo
Po	=	3.43824E-05
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.

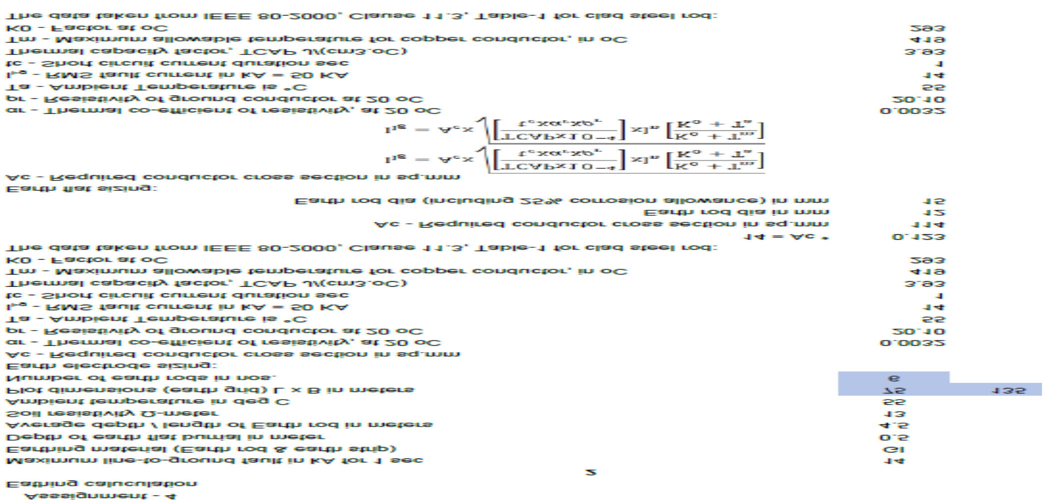
6 Down Conductors

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



5 thjune 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.

Assignment - 7

Cable tary 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	4	50	1	46	29	3.25	3.25	
2	PU 2314A	4	25	1	14	22	1.4	1.4	
3	PU2324	4	6	1	46	18	0.9	0.9	
4	PU2305	4	70	1	14	29	3.25	3.25	
5	MX2305	4	70	1	46	29	3.25	3.25	
6	MX2308	4	70	1	14	29	3.25	3.25	
7	BW2313	4	35	1	22	24	1.8	1.8	
8	SC2314	4	10	1	22	18	0.9	0.9	
9	AG2324A	4	6	1	40	18	0.9	0.9	
10	AG2305	4	25	1	26	22	1.4	1.4	
11	AG2309	4	10	1	26	18	0.9	0.9	
12	AG2310	4	10	1	26	18	0.9	0.9	
13	AG2314	4	16	1	28	21	1	1	
Total				13		296	23.1	23.1	

Assignment - 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 (A)	Load P.F. Running	SIN Φ Running	Motor P.F Staring	SIN Φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)
1	LV MCC	PU2315	Silica filter feed pump	66.68	75	415	3	116.0	695.76	0.8	0.6	0.8	0.5	2	1	4.0	50
2	LV MCC	PU 2314A	Absorbent/Neutral oil pump	19.37	22	415	3	33.7	202.11	0.8	0.6	0.8	0.5	2	1	4.0	25
3	LV MCC	PU2324	Citric Acid Tank pump	4.91	7.5	415	3	8.5	51.23	0.8	0.6	0.8	0.5	2	1	4.0	6
4	LV MCC	PU2305	Feed Pump(Seperator)	67.34	75	415	3	117.1	702.65	0.8	0.6	0.8	0.5	2	1	4.0	70
5	LV MCC	MX2305	Mixer	67.86	75	415	3	118.0	708.07	0.8	0.6	0.8	0.5	2	1	4.0	70
6	LV MCC	MX2308	Mixer	67.86	75	415	3	118.0	708.07	0.8	0.6	0.8	0.5	2	1	4.0	70
7	LV MCC	BW2313	Blower	29.13	37	415	3	50.7	303.95	0.8	0.6	0.8	0.5	2	1	4.0	35
8	LV MCC	SC2314	Screw conveyor	6.54	7.5	415	3	11.4	68.24	0.8	0.6	0.8	0.5	2	1	4.0	10
9	LV MCC	AG2324A	citric acid tan agitator	4.91	7.5	415	3	8.5	51.23	0.8	0.6	0.8	0.5	2	1	4.0	6
10	LV MCC	AG2305	citric oil rection vessel agitator	17.87	22	415	3	31.1	186.46	0.8	0.6	0.8	0.5	2	1	4.0	25
11	LV MCC	AG2309	lye oil reaction vessel agitator	6.50	9.2	415	3	11.3	67.82	0.8	0.6	0.8	0.5	2	1	4.0	10
12	LV MCC	AG2310	lye oil reaction vessel agitator	6.50	9.2	415	3	11.3	67.82	0.8	0.6	0.8	0.5	2	1	4.0	10
13	LV MCC	AG2314	Soap adsorbent tank agitator	11.37	15	415	3	19.8	118.64	0.8	0.6	0.8	0.5	2	1	4.0	16

S.NO.	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
1	#REF!	0.98	0.9	1	1	0.882	#REF!	95	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20
2	#REF!	0.98	0.9	1	1	0.882	#REF!	60	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
3	#REF!	0.98	0.9	1	1	0.882	#REF!	65	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
4	#REF!	0.98	0.9	1	1	0.882	#REF!	75	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20
5	#REF!	0.98	0.9	1	1	0.882	#REF!	75	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20
6	#REF!	0.98	0.9	1	1	0.882	#REF!	105	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20
7	#REF!	0.98	0.9	1	1	0.882	#REF!	95	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
8	#REF!	0.98	0.9	1	1	0.882	#REF!	65	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
9	#REF!	0.98	0.9	1	1	0.882	#REF!	65	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
10	#REF!	0.98	0.9	1	1	0.882	#REF!	75	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
11	#REF!	0.98	0.9	1	1	0.882	#REF!	65	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
12	#REF!	0.98	0.9	1	1	0.882	#REF!	65	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s
13	#REF!	0.98	0.9	1	1	0.882	#REF!	65	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	20s

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%

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.

ELECTRICAL LOAD CALCULATIONS LV MCC

Assignment-1

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					43.84	45.00	0.97	0.91	0.78	48.18	38.65					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					12.73	15.00	0.85	0.85	0.73	15.0	14.0					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					10.96	11.00	1.00	0.85	0.73					12.9	12.1	
4	PU2305	Feed Pump (Seperator)					44.28	45.00	0.98	0.91	0.78	48.7	39.0					
5	MX2305	MIXER (W)					44.62	45.00	0.99	0.91	0.78	49.0	39.3					
6	MX 2308	MIXER (S)					44.62	45.00	0.99	0.91	0.78					49.0	39.3	
7	BW2313	Blower					19.16	22.00	0.87	0.91	0.78	21.1	16.9					
8	Rotary valve	TK 2313B (I)					1.86	2.20	0.85	0.85	0.73			2.2	2.0			
9	SC2314	Screw conveyor (I)					4.30	4.70	0.91	0.85	0.73			5.06	4.74			
10	AG 2324A	Citric acid tan agitator (W)					3.23	3.70	0.87	0.85	0.73	3.80	3.56					
11	AG 2324B	Citric acid tank agitator (S)					3.23	3.70	0.87	0.85	0.73					3.8	3.6	
12	AG 2305	Citric oil rection vessol agitator					11.75	15.00	0.78	0.85	0.73	13.82	12.94					
13	AG 2309	Lye oil reaction vessel agitator					4.27	4.70	0.91	0.85	0.73	5.02	4.70					
14	AG 2310	Lye oil reaction vessel agitator					4.27	4.70	0.91	0.85	0.73	5.02	4.70					
15	AG 2314	Soap Adsorbant Tank Agitator					7.48	7.50	1.00	0.85	0.73	8.80	8.24					

Maximum of normal running plant load : (Est. x%E + y%F)	220.5 kW	184.1 kVAR	sqrt (kW² +kVAR²) = 287.3 kVA	TOTAL	218.37 / 182.09	7.25 / 6.78	65.73 / 54.97
Peak Load : (Est. x%E + y%F + z%G)	227.1 kW	189.6 kVAR	sqrt (kW² +kVAR²) = 295.9 kVA	kVA	284.32	9.93	85.68

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.

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Calculation for Transformer Capacity

Assignment-2

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	218.47	182.0	284.35	--- (i)
b.	Intermittent load / Diversity Factor	7.25	6.8	9.94	--- (ii)
c.	Stand-by load required as consumed load	65.73	55.0	85.71	--- (iii)

	kW	kVar	kVA
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	227.2	189.5	295.89
Future expansion load (20% capacity)	45.4	37.9	59.18
Total Load =	272.7	227.4	355.07

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	295.9 kVA
Spare capacity	=	59.2 kVA
Required capacity	=	355.1 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 :

218.37

P_T = 355 KVA (%Z)= 4 & Ratio X/R = 3.3

Hence , **%R** = 1.176 %

%X = 3.82 %

P_M = 45 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.η = 0.85 & Cos Θs = 0.25

P_S = 407.24 KVA

Cos θ_S = 0.25 ,Corresponding to Angle θ_s = 75.522 Degrees for which Sin θ_s = 0.97

P_B = 281.52 KVA & PB in KW is = 239.29 & P_B in Kvar = 273.05 ∴ Cos θ_B = 0.850

Cos θ_B = 0.85 ,Corresponding to Angle θ_s = 31.788 Degrees, for which Sin θ_s = 0.53

P_{CP} = 341.1 KW

P_{CQ} = 667.36 KVAR

P_C = 749.48 KVA

Cos θ_C = = 0.4551 , where as Sin θ_C = 0.890

Voltage Regulation ε = 8.3 %

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

1.4 Selection of rated capacity

120 kVA transformer selected.

ASSIGNMENT-3

DG SET SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.87	Avg
	Efficiency	0.74	Avg
	Total operating load on DG set in kVA at 0.87 power factor	**287.3**	
	Largest motor to start in the sequence - load in KW	45	KW
	Running kVA of last motor (CosØ= 0.91)	70	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)	**419**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**217**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**217**	**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	637	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)	**324**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	637	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)	**425**	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	217	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	324	KVA
	Overload capacity P3	425	KVA
	Considering the last value amongst P1, P2 and P3	**425**	**KVA**

Hence, Existing Generator 425 KVA is adequate to cater the loads as per re-scheduled loads

NOTE:VOLTAGE DIP CONSIDERED - 15%

ASSIGNMENT-4

EARTHING CALCULATIONS 2

Maximum line-to-ground fault in kA for 1 sec	16	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.5	
Average depth / length of Earth rod in meters	4.5	
Soil resistivity Ω-meter	11	
Ambient temperature in deg C	55	
Plot dimensions (earth grid) L x B in meters	80	140
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	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - RMS fault current in kA = 50 KA	16
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:	
16 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	130
Earth rod dia in mm	13
Earth rod dia (including 25% corrosion allowance) in mm	16

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	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - RMS fault current in kA = 50 KA	16
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:	
16 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	130
Earth flat area in mm	13
Earth flat area (including 25% corrosion allowance) in mm	16
Selected flat size W * Thk in sq mm	20

Rg - Grid resistance

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

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

ρ - Soil resistivity in Ω-meter=	11
L - Total buried length of ground conductor in meter	440
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	11200
Rg - Grid resistance	0.071

Rr - Earth Electrode resistance

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

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

ρ - Soil resistivity in Ω-meter, 16.96	11
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	4.5
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	11200
Rr - Earth Electrode resistance	4.04156

Grounding system resistance

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

$$R_g \text{ x } R_2 - R_m^2$$

LIGHTING CALCULATIONS

ASSIGNMENT-5

	1			
	Gwalior			
Location	Concrete, Hospital			
Building	Flat Roofs (a)			
Type of Building	20			
Building Length (L)	9			
Building breadth (W)	7			
Building Height (H)				

1 Risk Factor Calculation

Collection Area (A_c)		=	(L*W) + (2*L*H) + (2*W*H)	
A_c			739.86	
2				
Probability of Being Struck (P)		=	Ac * Ng * 10-6	
P			0.002737482	
3				
Overall weighing factor		=	1.7	
a) Use of structure (A)		=	1.0	
b) Type of construction (B)		=	1.7	
c) Contents or consequential effects (C)		=	1.0	
d) Degree of isolation (D)		=	0.3	
e) Type of country (E)		=	A * B * C * D * E	
Wo - Overall weighing factor		=	0.510	
4	Po	=	P * Wo	
Overall Risk Factor	Po	=	0.001396116	
	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			
	=	2(L+W)	
Perimeter of the building	=	58	Mts.
6			
Down Conductors	=	58	Mts.
Perimeter of building	=	3	Nos.
No. of down conductors based on perimeter			

Hence 3 nos. of Down conductors have been selected.

= 20 X 2.5 mm Galvanized Ste

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

CABLE SIZING CALCULATIONS ASSIGNMENT-6

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Motor Starting Current (A)	Load P.F. Running	SIN Φ Running	Motor P.F Staring	SIN Φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
3	LV MCC	PU2315	Silica filter feed pump	43.84	45.00	415	3	76.2	457.44	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	9.95	2.40	59.07	14.23	OK	22	20
4	LV MCC	PU2322A	Soft water pump	12.73	15.00	415	3	22.1	132.83	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	7.01	1.69	41.84	10.08	OK	18	20s
5	LV MCC	PU 2314A	Absorbesnt/Neutral oil pump	10.96	11.00	415	3	19.1	114.36	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	60	5.9000	0.0947	9.46	2.28	56.66	13.65	OK	17	20s
6	LV MCC	PU2324	Citric Acid Tank pump	44.28	45.00	415	3	77.0	462.03	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	8.99	2.17	53.38	12.86	OK	22	20s
7	LV MCC	PU2333	Slop Oil pump	44.62	45.00	415	3	77.6	465.58	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	75	0.9300	0.0816	7.99	1.93	47.46	11.44	OK	22	20s
8	LV MCC	PU 2322B	Soft water pump-Stand by	44.62	45.00	415	3	77.6	465.58	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1	0.882	130.5	105	0.6710	0.0794	8.25	1.99	48.81	11.76	OK	24	20s
9	LV MCC	PU2321A	Lye/Simplex Metering Pump	19.16	22.00	415	3	33.3	199.92	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	1	0.882	75.0	100	1.4700	0.0815	7.07	1.70	42.13	10.15	OK	21	20s
10	LV MCC	PU2321B	Lye storage tank pump	1.86	2.20	415	3	3.2	19.41	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	2.68	0.64	16.03	3.86	OK	17	20s
11	LV MCC	PU2305	Feed Pump(Seperator)	4.30	4.70	415	3	7.5	44.87	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	3.11	0.75	18.63	4.49	OK	18	20
12	LV MCC	PU2332	Saop Stock Pump	3.23	3.70	415	3	5.6	33.70	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	110	9.4800	0.1007	8.18	1.97	49.02	11.81	OK	16	20s
13	LV MCC	MX2305	Mixer	3.23	3.70	415	3	5.6	33.70	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	2.34	0.56	14.00	3.37	OK	18	20
14	LV MCC	MX2308	Mixer	11.75	15.00	415	3	20.4	122.60	0.8	0.6	0.8	0.5	2	1	4.0	10	66	0.98	0.9	1	1	0.882	58.2	105	2.3400	0.0852	7.15	1.72	42.69	10.29	OK	18	20
15	LV MCC	CF2312	Separator	4.27	4.70	415	3	7.4	44.55	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	0.87	0.21	5.15	1.24	OK	22	32
16	LV MCC	BW2313	Blower	4.27	4.70	415	3	7.4	44.55	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	9.34	2.25	55.97	13.49	OK	16	20s
17	LV MCC	RV 2314	Rotary valve	7.48	7.50	415	3	13.0	78.05	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	65	5.9000	0.0947	7.00	1.69	41.89	10.09	OK	17	20s
18																																		
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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%

CABLE TRAY SIZING CALCULATIONS ASSIGNMENT-7

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	4	25	1	22	**22**	1.4	**1.4**	
2	PU2322A	4	10	1	18	**18**	0.9	**0.9**	
3	PU 2314A	4	4	1	17	**17**	0.6	**0.6**	
4	PU2324	4	25	1	22	**22**	1.4	**1.4**	
5	PU2333	4	25	1	22	**22**	1.4	**1.4**	
6	PU 2322B	4	35	1	24	**24**	1.8	**1.8**	
7	PU2321A	4	16	1	21	**21**	1	**1**	
8	PU2321B	4	4	1	17	**17**	0.6	**0.6**	
9	PU2305	4	6	1	18	**18**	0.7	**0.7**	
10	PU2332	4	2.5	1	16	**16**	0.5	**0.5**	
11	MX2305	4	6	1	18	**18**	0.7	**0.7**	
12	MX2308	4	10	1	18	**18**	0.9	**0.9**	
13	CF2312	4	25	1	22	**22**	1.4	**1.4**	
14	BW2313	4	2.5	1	1.6	**1.6**	0.5	**0.5**	
15	RV 2314	4	4	1	17	**17**	0.6	**0.6**	
Total				**15**		**273.6**	**14.4**	**14.4**	

Calculation

Maximum Cable Diameter:	24	mm
Consider Spare Capacity of Cable Tray:	30%	
Distance between each Cable:	0	mm
Calculated Width of Cable Tray:	356	mm
Calculated Area of Cable Tray:	8536	Sq.mm
No of Layer of Cables in Cable Tray:	2	
Selected No of Cable Tray:	1	Nos.
Selected Cable Tray Width:	300	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:	30000	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:	300 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	41%	
Cable Tray Area Remaning:	72%	