Internship Program Report

By

Gandham naga ratna priya – 19485A0231

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 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. Rama Krishna –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

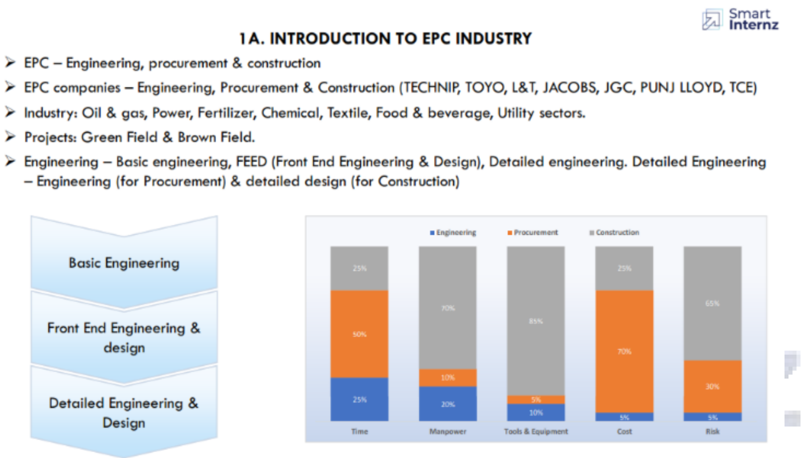
Presenter: Mr Ramesh V

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

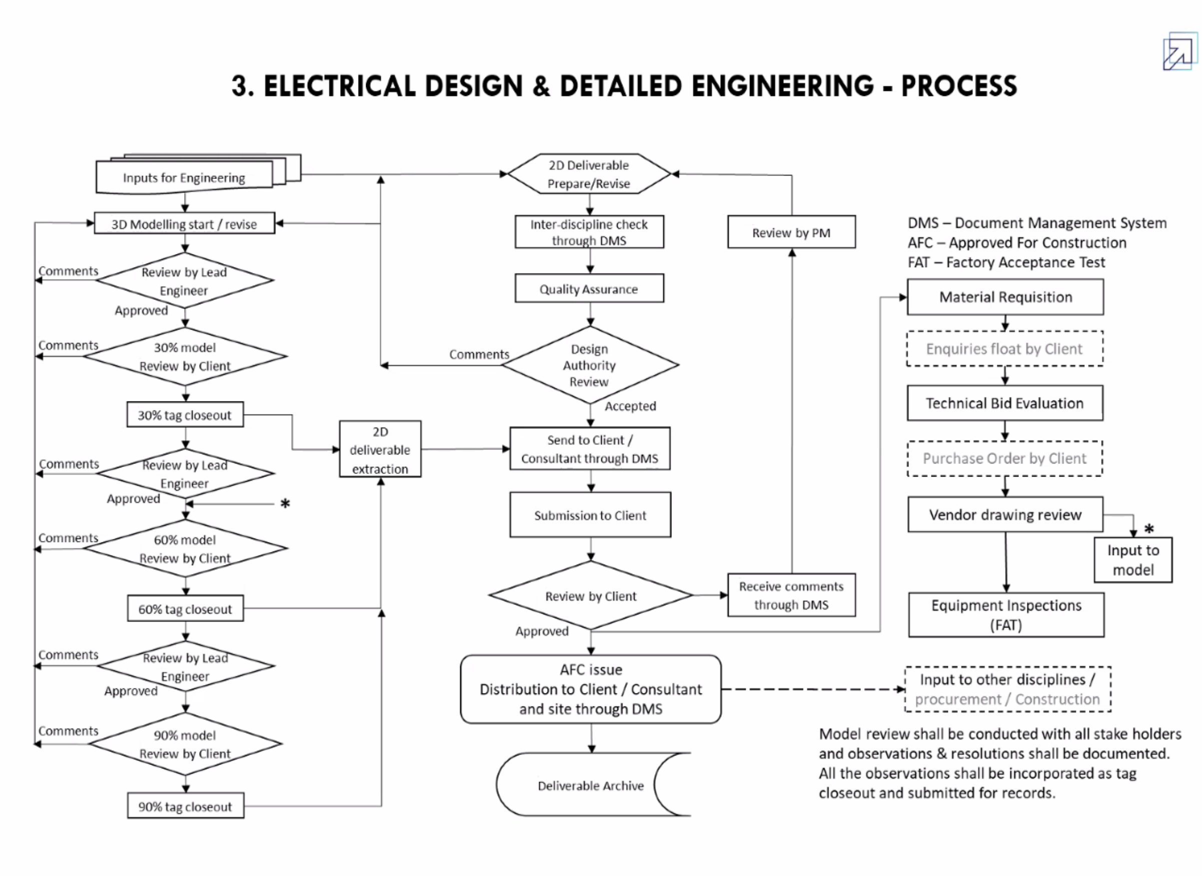


Topic details:

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: Drawing for EPC projects

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
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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
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		POINT	PO	BRAKE	BR		
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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:

Basics line diagrams andlayouts commends.

28th May2021: SLD and Load for EPC projects

4	Estimation of Plant Electrical Load & SLD	Load List / Power balance	Load / Maximum demand calculation
		Single Line Diagram	Development of SLD
		Power Distribution system	Various power distribution systems

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					38.12	45.00	0.85	0.91	0.78	41.89	33.61					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					11.07	15.00	0.74	0.85	0.73	13.0	12.2					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					9.53	11.00	0.87	0.85	0.73					11.2	10.5	
4	PU2305	Feed Pump (Seperator)					38.50	45.00	0.86	0.91	0.78	42.3	33.9					
5	MX2305	MIXER (W)					38.80	45.00	0.86	0.91	0.78	42.6	34.2					
6	MX 2308	MIXER (S)					38.80	45.00	0.86	0.91	0.78					42.6	34.2	
7	BW2313	Blower					16.66	18.50	0.90	0.85	0.73	19.6	18.4					
8	Rotary valve	TK 2313B (I)					1.62	2.20	0.74	0.85	0.73			1.9	1.8			
9	SC2314	Screw conveyor (I)					3.74	4.70	0.80	0.85	0.73			4.40	4.12			
10	AG 2324A	Citric acid tan agitator (W)					2.81	3.00	0.94	0.85	0.73	3.31	3.10					
11	AG 2324B	Citric acid tank agitator (S)					2.81	3.00	0.94	0.85	0.73					3.3	3.1	
12	AG 2305	Citric oil rection vessol agitator					10.22	11.00	0.93	0.85	0.73	12.02	11.26					
13	AG 2309	Lye oil reaction vessel agitator					3.71	4.70	0.79	0.85	0.73	4.36	4.09					
14	AG 2310	Lye oil reaction vessel agitator					3.71	4.70	0.79	0.85	0.73	4.36	4.09					
15	AG 2314	Soap Adsorbant Tank Agitator					6.50	7.50	0.87	0.85	0.73	7.65	7.16					
		Maximum of normal running plant load : (Est. x%E + y%F)	193.1 kW		163.8 kVAR		sqrt (kW² +kVAR²) =	253.2 kVA			TOTAL	191.16	161.98	6.31	5.90	57.16	47.80	
		Peak Load : (Est. x%E + y%F + z%G)	198.8 kW		168.5 kVAR		sqrt (kW² +kVAR²) =	260.6 kVA			kVA	250.57		8.64		74.51		

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

Topic details:

List of electrical loads indicating continuous, intermittent & standby loads.

29th May2021: Sizing for EPC projects

5	Equipment Selection & Sizing	Transformer	Types, Sizing / selection
		DG Set	Types, Sizing / selection

6		SWGR	Types, Sizing / selection
		APFC	Types, Sizing / selection
7		UPS	Types, Sizing / selection
		Bus Duct	Types, Sizing / selection
8		Motor starters /Drives	Types, Sizing / selection
		Motors	Types, Sizing / selection

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	191.16	162.0	250.56	--- (i)
b. Intermittent load / Diversity Factor	6.31	5.9	8.64	--- (ii)
c. Stand-by load required as consumed load	57.16	47.8	74.51	--- (iii)
Max. Consumed load - ((i) + 30% (ii) + 10% (iii)) -	198.8	168.5	260.60	
Future expansion load (20% capacity)	39.8	33.7	52.12	
Total Load -	238.5	202.2	312.72	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	-	260.6 kVA
Spare capacity	-	52.1 kVA
Required capacity	-	312.7 kVA
Transformer rated capacity	-	120

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 - 312.7 KVA (%Z)- 4.12 & Ratio X/R - 3.9

Hence, %R - - 1.036 %

%X - - 3.99 %

P_M - 45 KW having (K - 6 & C - 1 & Cos θ = 0.78 & Eff.η = 0.91 & Cos θs = 0.3

P_S - - 380.39 KVA

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

P_P - 225.89 KVA & PB in KW is - 117.46 & P_P in Kvar - 192.006 ∴ Cos $θ_P$ - 0.520

Cos $θ_P$ - 0.85 ,Corresponding to Angle $θ_s$ - 58.669 Degrees, for which Sin $θ_s$ - 0.85

P_{CP} - - 212.56 KW

P_{CQ} - - 560.32 KVAR

P_C - - 599.28 KVA

Cos $θ_C$ - - 0.3547 , where as Sin $θ_C$ - 0.935

Voltage Regulation ε = 7.8 %

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.

Topic details:

Transformer and DG set calculations,types ,sizing or selections

2nd june2021: Caluculation of lightning and earthing for EPC projects

9	Earthing& Lightning protection	Earthing	Calculations, Procedure & Layouts
		Lightning Protection	Calculations, Procedure & Layouts

Lightning calculation:

		10				
	Location	Vadodara				
	Building	Srtuctural, Industrial				
	Type of Building	Triangle Roofs (c)				
	Building Length (L)	13				
	Building breadth (W)	7				
	Building Height (H)	6				
	Risk Factor Calculation					
1	**Collection Area (A_e)**					
	A_e			=	(3.14*H*H)+(2*H*L)	
					269.04	
2	**Probability of Being Struck (P)**					
	P			=	A_e * N_g * 10^{-6}	
					0.00013452	
3	**Overall weighing factor**					
	a) Use of structure (A)			=	1.3	
	b) Type of construction (B)			=	0.8	
	c) Contents or consequential effects (C)			=	1.3	
	d) Degree of isolation (D)			=	1.0	
	e) Type of country (E)			=	0.3	
	Wo - Overall weighing factor			=	A * B * C * D * E	
				=	0.406	
4	**Overall Risk Factor**		Po	=	P * Wo	
			Po	=	5.4561E-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)	
				=	40	Mts.
6	**Down Conductors**					
	Perimeter of building			=	40	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)					

Topic details:

Lightning and earthing protection calculations and procedure

21st May2021: procedure of indoor and outdoor for EPC projects

10	Illumination system	Indoor & Outdoor	Procedure & Layouts
11		Indoor & Outdoor	Calculations with Dialux software


Topic details:

Indoor and outdoor procedure and layouts calculations with Dialux software

5 thjune2021: Cable sizing for EPC projects

12	Cabling	Types of cables	Cables usage
			Types of laying
13		Cable sizing calculations	Types of calculations

Cable sizing calculations

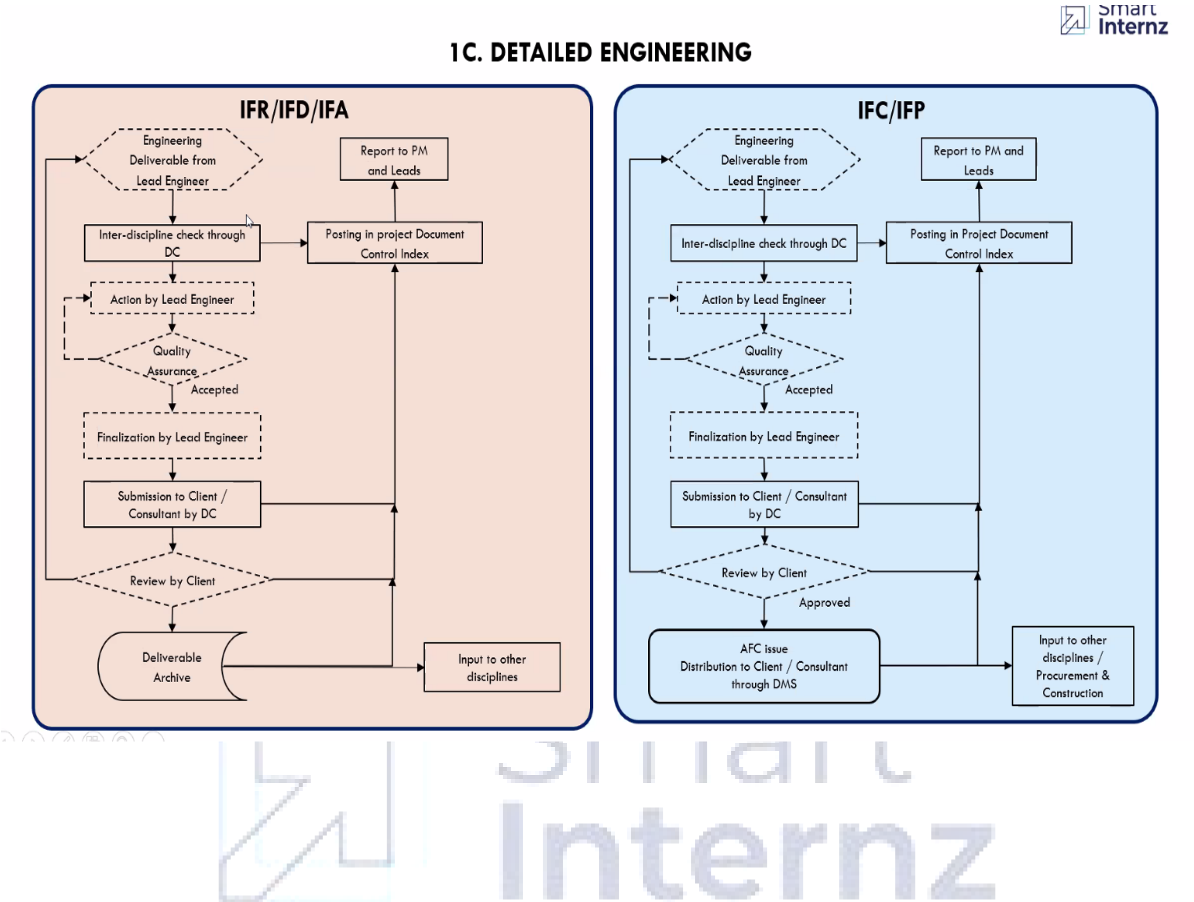
No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	95	0.9300	0.0816	8.65	2.08	51.36	12.38	OK	22	20
1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	95	3.9400	0.0902	10.16	2.45	60.76	14.64	OK	18	20s
1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	60	5.9000	0.0947	8.23	1.98	49.26	11.87	OK	17	20s
1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	85	0.9300	0.0816	7.82	1.88	46.41	11.18	OK	22	20s
1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	75	0.9300	0.0816	6.95	1.67	41.27	9.95	OK	22	20s
1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	105	0.9300	0.0816	9.73	2.34	57.78	13.92	OK	22	20s
1	4.0	10	66	0.98	0.9	1	1	0.882	58.2	100	2.3400	0.0852	9.65	2.33	57.65	13.89	OK	18	20s
1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	100	9.4800	0.1007	3.73	0.90	22.35	5.39	OK	16	20s
1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	2.71	0.65	16.21	3.91	OK	18	20
1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	110	9.4800	0.1007	7.12	1.71	42.65	10.28	OK	16	20s
1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	2.04	0.49	12.18	2.93	OK	18	20
1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	10.36	2.50	62.00	14.94	OK	18	20
1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	85	0.9300	0.0816	0.75	0.18	4.47	1.08	OK	22	32
1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	8.12	1.96	48.63	11.72	OK	16	20s
1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	65	9.4800	0.1007	9.73	2.34	58.29	14.05	OK	16	20s

Topic details:

Cable sizing calculations for LV cables and MV/HV cables shall be performed for each load based on cable laying conditions.

7th May2021: Overall plant description for EPC project

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



Topic details :

Overall plant description ,approach to detailed design.

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					38.12	45.00	0.85	0.91	0.78	41.89	33.61					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					11.07	15.00	0.74	0.85	0.73	13.0	12.2					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					9.53	11.00	0.87	0.85	0.73					11.2	10.5	
4	PU2305	Feed Pump (Seperator)					38.50	45.00	0.86	0.91	0.78	42.3	33.9					
5	MX2305	MIXER (W)					38.80	45.00	0.86	0.91	0.78	42.6	34.2					
6	MX 2308	MIXER (S)					38.80	45.00	0.86	0.91	0.78					42.6	34.2	
7	BW2313	Blower					16.66	18.50	0.90	0.85	0.73	19.6	18.4					
8	Rotary valve	TK 2313B (I)					1.62	2.20	0.74	0.85	0.73			1.9	1.8			
9	SC2314	Screw conveyor (I)					3.74	4.70	0.80	0.85	0.73			4.40	4.12			
10	AG 2324A	Citric acid tan agitator (W)					2.81	3.00	0.94	0.85	0.73	3.31	3.10					
11	AG 2324B	Citric acid tank agitator (S)					2.81	3.00	0.94	0.85	0.73					3.3	3.1	
12	AG 2305	Citric oil rection vessol agitator					10.22	11.00	0.93	0.85	0.73	12.02	11.26					
13	AG 2309	Lye oil reaction vessel agitator					3.71	4.70	0.79	0.85	0.73	4.36	4.09					
14	AG 2310	Lye oil reaction vessel agitator					3.71	4.70	0.79	0.85	0.73	4.36	4.09					
15	AG 2314	Soap Adsorbant Tank Agitator					6.50	7.50	0.87	0.85	0.73	7.65	7.16					

Maximum of normal running plant load : (Est. x%E + y%F)	193.1 kW	163.8 kVAR	sqrt (kW² +kVAR²) =	253.2 kVA	TOTAL	191.16	161.98	6.31	5.90	57.16	47.80
Peak Load : (Est. x%E + y%F + z%G)	198.8 kW	168.5 kVAR	sqrt (kW² +kVAR²) =	260.6 kVA	kVA	250.57		8.64		74.51	

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 3

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	191.16	162.0	250.56	--- (i)
b. Intermittent load / Diversity Factor	6.31	5.9	8.64	--- (ii)
c. Stand-by load required as consumed load	57.16	47.8	74.51	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	198.8	168.5	260.60	
Future expansion load (20% capacity)	39.8	33.7	52.12	
Total Load =	238.5	202.2	312.72	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	260.6 kVA
Spare capacity	=	52.1 kVA
Required capacity	=	312.7 kVA
Transformer rated capacity	=	120

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 = 312.7 KVA (%Z)= 4.12 & Ratio X/R = 3.9

Hence , **%R** = = 1.036 %

%X = = 3.99 %

P_M = 45 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.η = 0.91 & Cos Θs = 0.25

P_S = = 380.389 KVA

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

P_B = 225.89 KVA & PB in KW is = 117.46 & P_B in Kvar = 192.006 ∴ Cos θ_B = 0.520

Cos θ_B = 0.85 ,Corresponding to Angle θ_s = 58.6686 Degrees, for which Sin θ_s = 0.85

P_{CP} = = 212.557 KW

P_{CQ} = = 560.316 KVAR

P_C = = 599.278 KVA

Cos θ_C = = 0.35469 , where as Sin θ_C = 0.935

Voltage Regulation ε = 7.8 %

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 2

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.74	Avg
	Efficiency	0.86	Avg
	Total operating load on DG set in kVA at 0.74 power factor	**253.2**	
	Largest motor to start in the sequence - load in KW	45	KW
	Running kVA of last motor (CosØ= 0.91)	71	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)	**424**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**182**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**182**	**KVA**
B	**Transient Voltage dip during starting of Last motor P2**		
	Total momentary load in KVA	607	KVA
	(Starting KVA of the last motor+Base load of DG set in 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 <u>(1-Transient Voltage Dip)</u> (Transient Voltage Dip)	**309**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	607	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) = <u>Total momentary load in KVA</u> overcurrent capacity of DG (K)	**405**	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	182	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	309	KVA
	Overload capacity P3	405	KVA
	Considering the last value amongst P1, P2 and P3	**405**	**KVA**

Hence, Existing Generator 405 KVA is adequate to cater the loads as per re-scheduled loads

NOTE:VOLTAGE DIP CONSIDERED - 15%

assignment 4

	10	
Maximum line-to-ground fault in kA for 1 sec	14	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.5	
Average depth / length of Earth rod in meters	4	
Soil resistivity Ω-meter	17	
Ambient temperature in deg C	50	
Plot dimensions (earth grid) L x B in meters	65	125
Number of earth rods in nos.	6	

Earth electrode sizing:

Ac - Required conductor cross section in sq.mm

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

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

Earth flat sizing:

Ac - Required conductor cross section in sq.mm

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

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	14
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:	

Ac - Required conductor cross section in sq.mm	114
Earth flat area in mm	12
Earth flat area (including 25% corrosion allowance) in mm	15
Selected flat size W * Thk in sq mm	20

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=	17
L - Total buried length of ground conductor in meter	380
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	8125
Rg - Grid resistance	0.128

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	17
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	6.73641

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

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

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 0.126 Ohms

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

assignment 5

lightning calculations	10
Location	Vadodara
Building	Srtuctural, Industrial
Type of Building	Triangle Roofs (c)
Building Length (L)	13
Building breadth (W)	7
Building Height (H)	6

Risk Factor Calculation

1 **Collection Area (A_c)**

A_c		=	(3.14*H*H)+(2*H*L)
			269.04

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

P		=	$A_c * N_g * 10^{-6}$
			0.00013452

3 **Overall weighing factor**

a) Use of structure (A)		=	1.3
b) Type of construction (B)		=	0.8
c) Contents or consequential effects (C)		=	1.3
d) Degree of isolation (D)		=	1.0
e) Type of country (E)		=	0.3
Wo - Overall weighing factor		=	A * B * C * D * E
		=	0.406

4 **Overall Risk Factor**

	Po	=	P * Wo
	Po	=	5.45613E-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)	
	=	40	Mts.

6 **Down Conductors**

Perimeter of building	=	40	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 Ste
(As per BS6651, lightning currents have very short duration, therefore thermal factors
are of little consequence in deciding the cross-section of the conductor. The minimum size
of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)

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	38.12	45.00	415	3	66.3	397.76	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	8.65	2.08	51.36	12.38	OK	22	20
4	LV MCC	PU2322A	Soft water pump	11.07	15.00	415	3	19.3	115.51	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	95	3.9400	0.0902	10.16	2.45	60.76	14.64	OK	18	20s
5	LV MCC	PU 2314A	Absorbesnt/Neutral oil pump	9.53	11.00	415	3	16.6	99.44	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	8.23	1.98	49.26	11.87	OK	17	20s
6	LV MCC	PU2324	Citric Acid Tank pump	38.50	45.00	415	3	67.0	401.72	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	7.82	1.88	46.41	11.18	OK	22	20s
7	LV MCC	PU2333	Slop Oil pump	38.80	45.00	415	3	67.5	404.85	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	6.95	1.67	41.27	9.95	OK	22	20s
8	LV MCC	PU 2322B	Soft water pump-Stand by	38.80	45.00	415	3	67.5	404.85	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	9.73	2.34	57.78	13.92	OK	22	20s
9	LV MCC	PU2321A	Lye/Simplex Metering Pump	16.66	18.50	415	3	29.0	173.84	0.8	0.6	0.8	0.5	2	1	4.0	10	66	0.98	0.9	1	1	0.882	58.2	100	2.3400	0.0852	9.65	2.33	57.65	13.89	OK	18	20s
10	LV MCC	PU2321B	Lye storage tank pump	1.62	2.20	415	3	2.8	16.90	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	100	9.4800	0.1007	3.73	0.90	22.35	5.39	OK	16	20s
11	LV MCC	PU2305	Feed Pump(Seperator)	3.74	4.70	415	3	6.5	39.02	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	2.71	0.65	16.21	3.91	OK	18	20
12	LV MCC	PU2332	Saop Stock Pump	2.81	3.00	415	3	4.9	29.32	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	7.12	1.71	42.65	10.28	OK	16	20s
13	LV MCC	MX2305	Mixer	2.81	3.00	415	3	4.9	29.32	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	2.04	0.49	12.18	2.93	OK	18	20
14	LV MCC	MX2308	Mixer	10.22	11.00	415	3	17.8	106.64	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	10.36	2.50	62.00	14.94	OK	18	20
15	LV MCC	CF2312	Separator	3.71	4.70	415	3	6.5	38.71	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	0.75	0.18	4.47	1.08	OK	22	32
16	LV MCC	BW2313	Blower	3.71	4.70	415	3	6.5	38.71	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	8.12	1.96	48.63	11.72	OK	16	20s
17	LV MCC	RV 2314	Rotary valve	6.50	7.50	415	3	11.3	67.82	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	65	9.4800	0.1007	9.73	2.34	58.29	14.05	OK	16	20s

assignment 7

LT CABLES

CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No	Cable Route (From-To)	Type & Cable Size	e of Cable (m	o. of Cabl	ameter of each C	n of Cable OD(m	Weight of Cable(Kg/	Veight of Cable(K	Remarks
1	PU2315	4	25	1	22	**22**	1.4	**1.4**	
2	PU2322A	4	6	1	18	**18**	0.7	**0.7**	
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	25	1	22	**22**	1.4	**1.4**	
7	PU2321A	4	10	1	18	**18**	0.9	**0.9**	
8	PU2321B	4	2.5	1	16	**16**	0.5	**0.5**	
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	6	1	18	**18**	0.7	**0.7**	
13	CF2312	4	25	1	22	**22**	1.4	**1.4**	
14	BW2313	4	2.5	1	16	**16**	0.5	**0.5**	
15	RV 2314	4	2.5	1	16	**16**	0.5	**0.5**	
Total				**15**		**281**	**13.3**	**13.3**	

Calculation

Maximum Cable Diameter:	**22**	**mm**
Consider Spare Capacity of Cable Tray:	**30%**	
Distance between each Cable:	**0**	**mm**
Calculated Width of Cable Tray:	**365**	**mm**
Calculated Area of Cable Tray:	**8037**	**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	**39%**	
Cable Tray Area Remaning:	**87%**	