

Internship Program

ReportBy

Sai kumar Dharmavarapu-19485A0245



In association with



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Introduction

Internship program arranged by GUDLAVALLERU ENGINEERING COLLEGE in association with Smart Internz, Hyderabad for the benefit of 3rd year EEE batch 2018-2022 on Electrical Detailed design Engineering for Oil& Gas, Power and Utility industrial sectors.

Program organiser

Smart Bridge, Hyderabad.

Pioneer in organising Internships, knowledge workshops, debates, hackathons, Technical



sessions and Industrial Automation projects.

Courtesy

Dr. Sri B. Dasu – HOD – EEE, GEC

Mr. G. Srinivasa Rao – Internship

coordinator Mr. Ramesh V - Mentor

Mr. Vinay Kumar - System Support

Mr. Harikanth – Software/Technical Support

Program details

Smart Internz program schedule: 4 weeks starting from 3rd May 2021

Daily schedule time shall be 4PM to 6.30PM

Mode of Classes: On line through

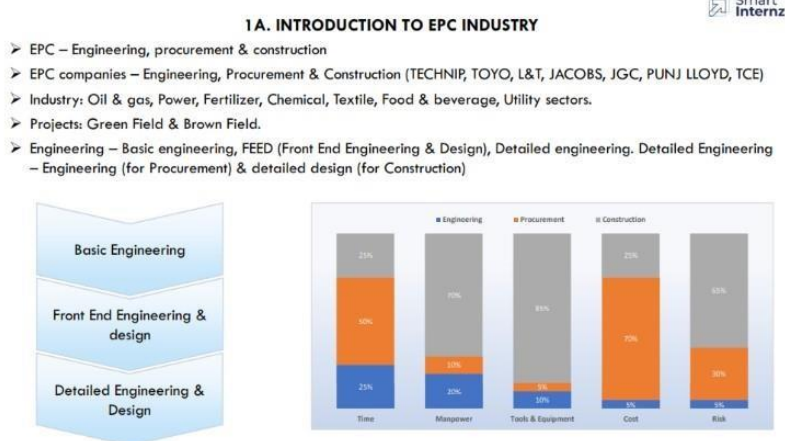
ZOOM Presenter: Mr Ramesh V

Internship program

We have been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design engineering for various industrial sectors.

3rd May2021: Introduction to EPC Industry

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



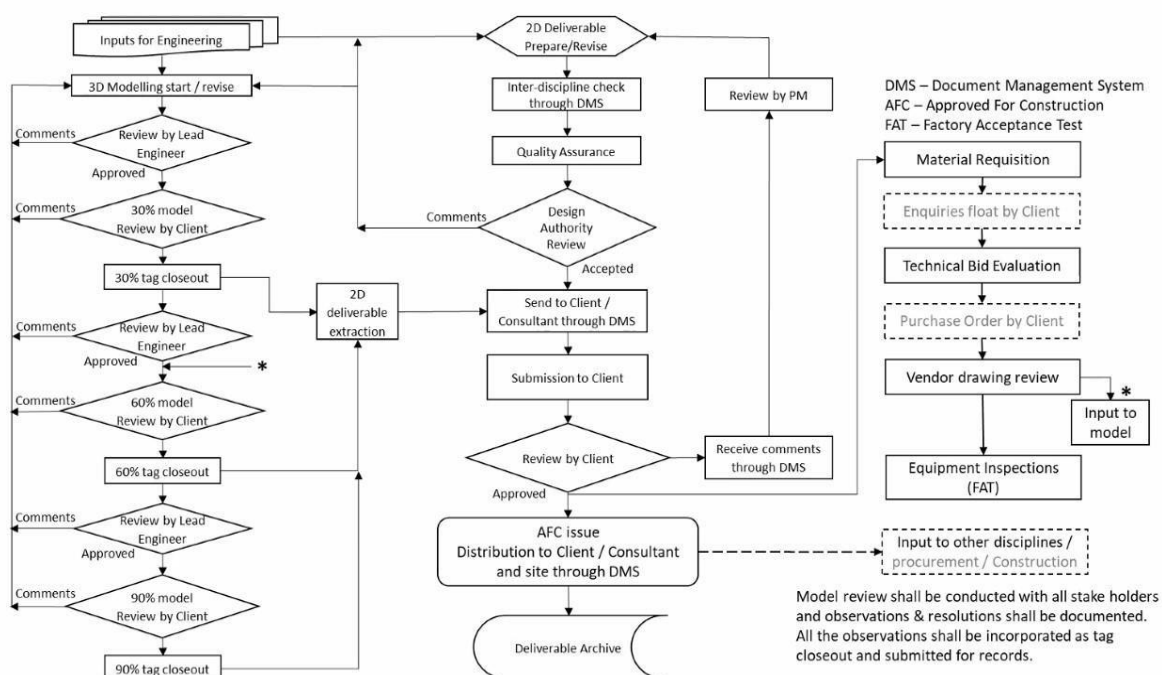
Topic details:

Engineering phases, Engineering deliverables (drawings & documents) list, Design Engineerrole 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 & Drawingtools | MS Word | Report / Calculations formats |
| | | MS Excel | Basic excel commands |

3C. AUTOCAD BASIC COMMANDS



| AUTOCAD BASIC KEYS | | | | | | | |
|--------------------|---------|-----------|-----|---------|-----|--------------|-----|
| STANDARD | | DRAW | | MODIFY | | FORMAT | |
| NEW | Ctrl+N | LINE | L | ERASE | E | PROPERTIES | MO |
| OPEN | Ctrl+O | RAY | RAY | COPY | CO | SELECT COLOR | COL |
| SAVE | Ctrl+S | PLINE | PL | MIRROR | MI | LAYER | LA |
| PLOT | Ctrl+P | 3DPOLY | 3P | OFFSET | O | LINETYPE | LT |
| PLOT PREVIEW | PRE | POLIGONE | POL | ARRAY | AR | LINEWEIGHTS | LW |
| CUT | Ctrl+X | RECTANGLE | REC | MOVE | M | LT SCALE | LTS |
| COPY | Ctrl+C | ARC | A | ROTATE | RO | LIST | LI |
| PASTE | Ctrl+V | CIRCLE | C | SCALE | SC | DIMEN. STYLE | D |
| MATCH PROPE. | MA | SPLINE | SPL | STRECH | S | RENAME | REN |
| CLOSE | Ctrl+F4 | ELLIPSE | EL | TRIM | TR | OPTION | OP |
| EXIT | Ctrl+Q | BLOCK | B | 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 | | | |
| COMMAND 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..

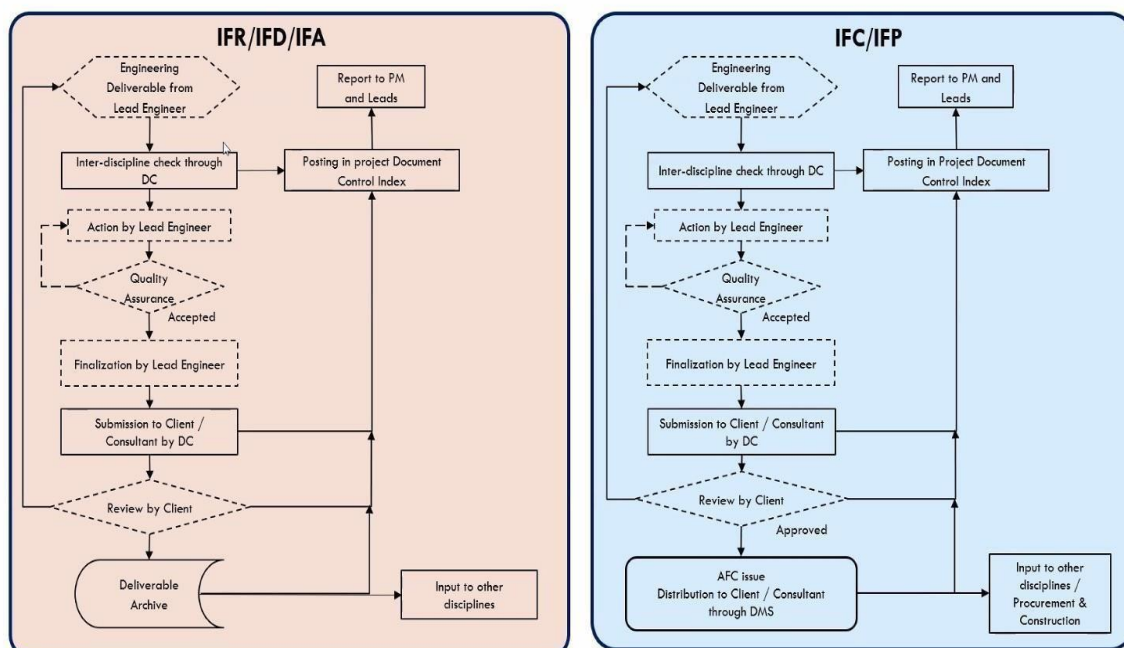
7 th May2021: Engineering documentation for Electrical system design

| | | |
|---|--|-----------------------------|
| 4 | Electrical system design for a small small project | Overall plant description |
| | | Sequence of approach |
| | | Approach to detailed design |

Topic details:



1C. DETAILED ENGINEERING



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

11th May2021: Classification of Transformers and Generators

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

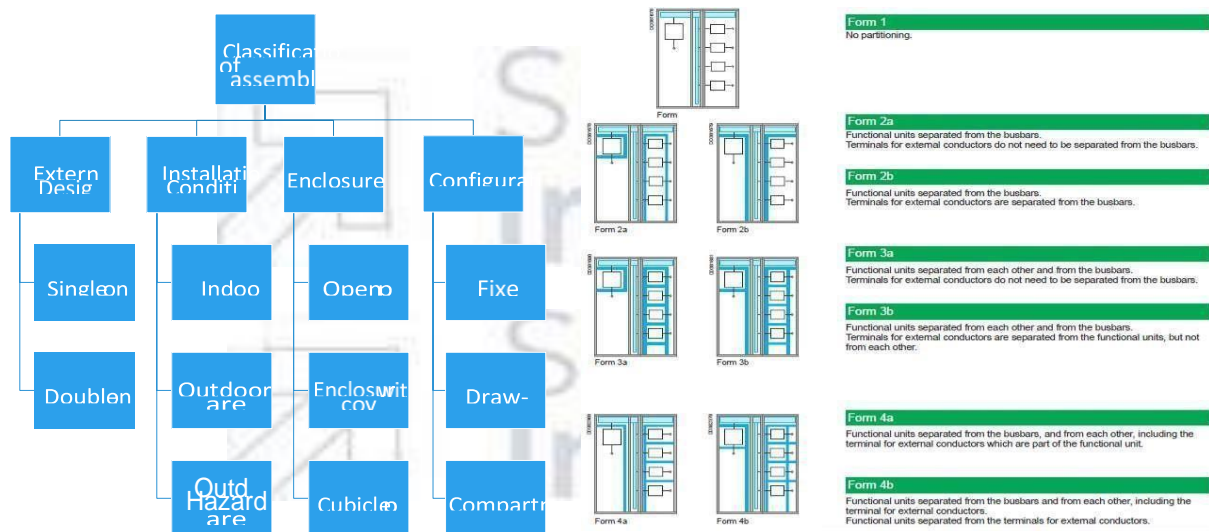


Topic details:

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 assemblies | Power factor 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

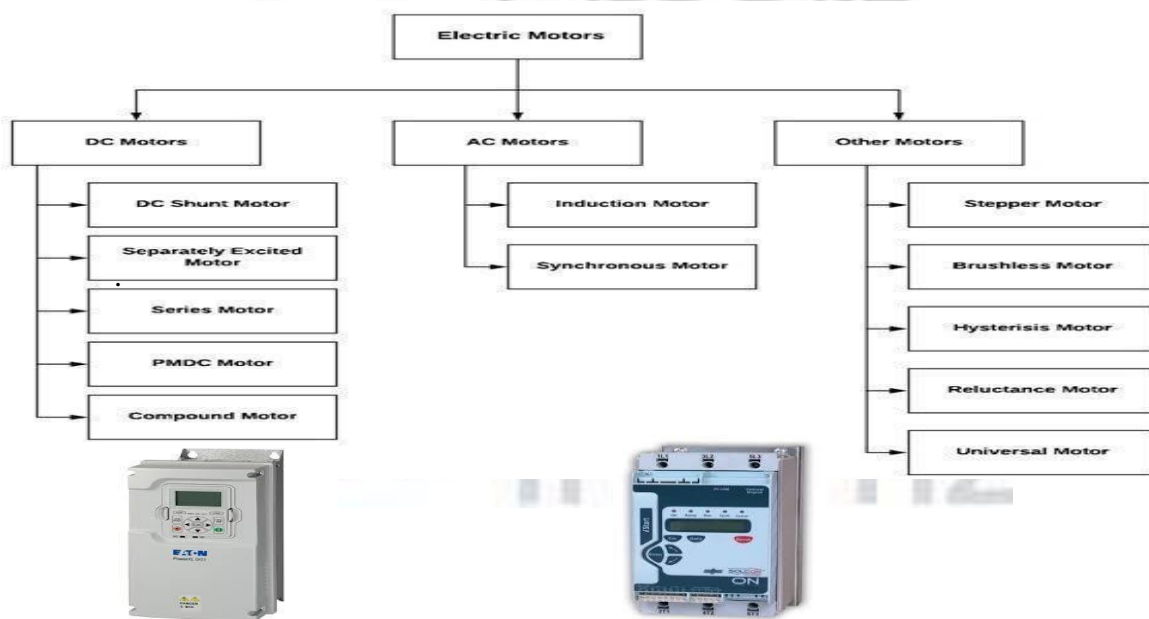
110V or 230V
AC UPS System

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.

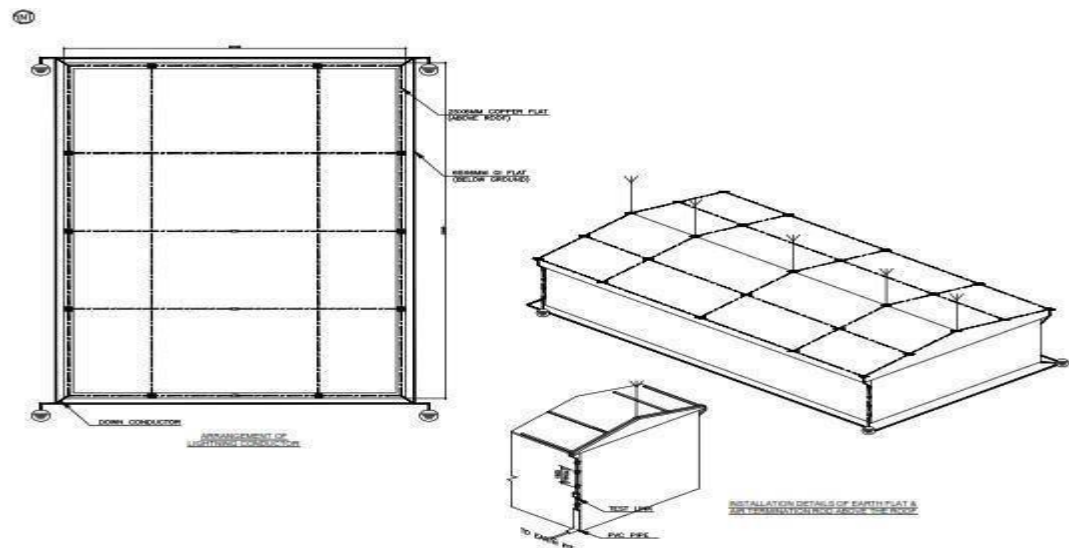
The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is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

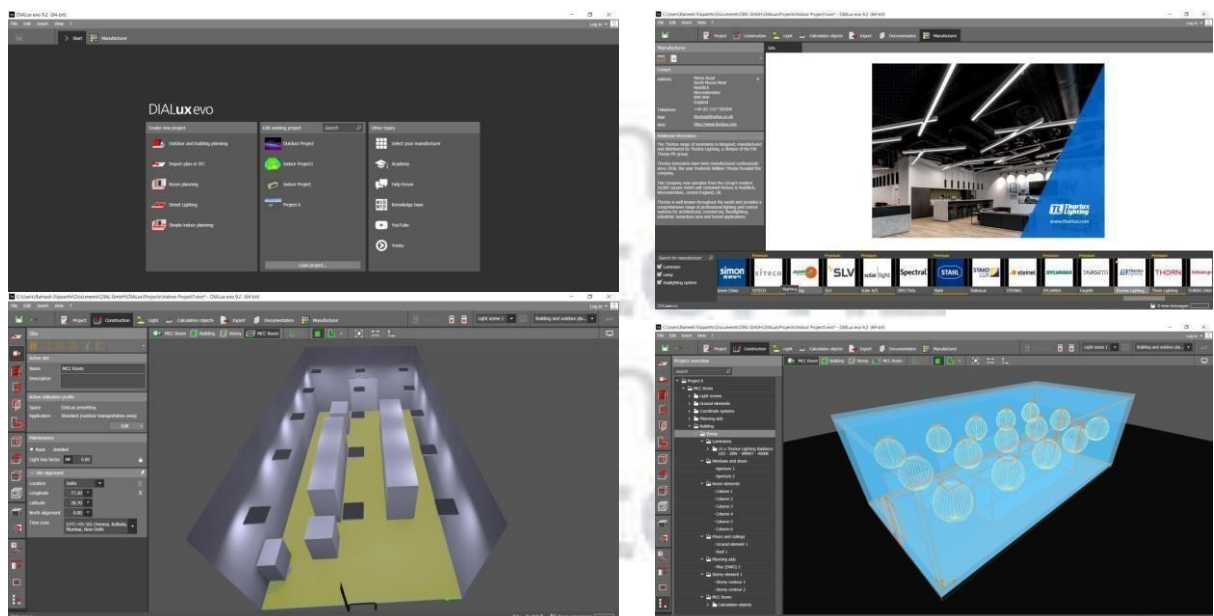
Types of light fittings: Industrial, flame proof type (EX d), increased safety type (Ex e).

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 |
|----|--|----------------------|----------------------------|

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.

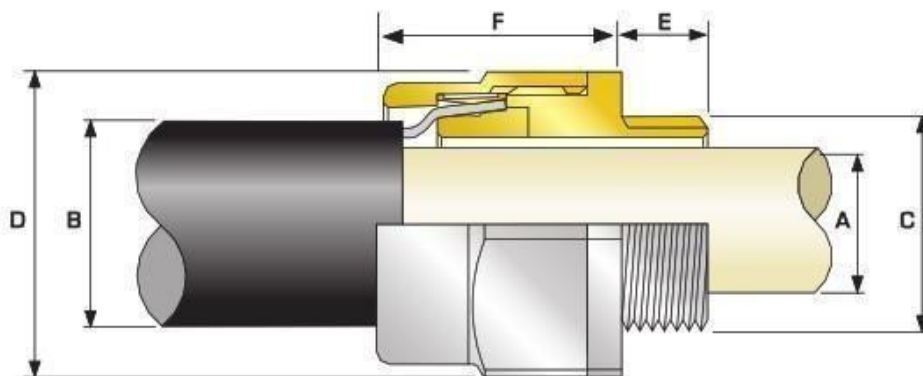
| | | | |
|----|--|----------------------|-----------------------|
| 14 | Cabling calculations and cable gland selection | Cabling calculations | Cable gland selection |
|----|--|----------------------|-----------------------|

Topic details: Cable sizing calculation and cable gland selection.

Inputs required: Load List, Design basis, Electrical equipment layout, cable schedule, vendor catalogues for cable tray.

Cable tray sizing shall be performed for each branch of cable tray routing up to the load point. Results shall be checked with specified limits mentioned in design basis.

Cable gland:



Cable Gland Selection Table

Refer to illustration at the top of the page.

| Cable Gland Size | Available Entry Threads "C" (Alternate Metric Thread Lengths Available) | | Cable Bedding Diameter "A" | Overall Cable Diameter "B" | Armour Range | | Across Flats "D" | Across Corners "D" | Protrusion Length "F" |
|------------------|---|----------------------------|----------------------------|----------------------------|--------------|------|------------------|--------------------|-----------------------|
| | Metric | Thread Length (Metric) "E" | Max | Max | 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 | Breaker Type | Breaker No. of Poles | ELCB Rating | Absorbed Load (A) | Motor / Load Rating (B) | Load Factor (A) / (B) | Efficiency (C) | Power Factor (D) | kW = [A] / [B] | | Consumed Load | | kVAR = kW x tan φ | Remarks | |
| | | | | | | | (kW) | (kW) | | | | Continuous | Intermittent | Stand-by | | | | |
| | | | | | | | | | | | | kW | kVAR | kW | kVAR | kW | kVAR | |
| 1 | RU231E | Static filter feed pump | | | | | 101.41 | 110.00 | 0.92 | 0.93 | 0.99 | 109.94 | 75.11 | | | | | |
| 2 | RU 231E-A | Automatic Recirculation oil pump (W) | | | | | 24.46 | 30.00 | 0.81 | 0.91 | 0.99 | 26.4 | 26.0 | | | | | |
| 3 | RU 231E-B | Automatic Recirculation oil pump (S) | | | | | 25.33 | 30.00 | 0.84 | 0.91 | 0.99 | 27.8 | 27.8 | | | 27.8 | 22.9 | |
| 4 | RU230E | Feed pump (displacement) | | | | | 102.43 | 110.00 | 0.93 | 0.93 | 0.99 | 110.1 | 77.9 | | | | | |
| 5 | RU230E | Feed pump (W) | | | | | 103.21 | 110.00 | 0.94 | 0.93 | 0.99 | 111.0 | 77.9 | | | 111.0 | 77.9 | |
| 6 | Max 230E | Mixer (S) | | | | | 104.21 | 110.00 | 0.84 | 0.93 | 0.99 | 49.7 | 35.1 | | | | | |
| 7 | RU231E | Blower | | | | | 44.33 | 45.00 | 0.91 | 0.76 | 0.99 | 46.7 | 35.1 | | | 4.7 | | |
| 8 | RU231E | Static compressor (I) | | | | | 9.66 | 11.00 | 0.93 | 0.93 | 0.99 | 11.11 | 10.99 | | | | | |
| 9 | AS 232A | Crane and tank agitator (W) | | | | | 7.46 | 7.50 | 0.94 | 0.73 | 0.99 | 8.60 | 8.24 | | | | | |
| 10 | AS 232B | Crane and tank agitator (S) | | | | | 7.49 | 7.50 | 0.95 | 0.73 | 0.99 | 8.60 | 8.24 | | | 8.6 | 8.2 | |
| 11 | AS 230E | Crane oil recirculation agitator | | | | | 27.14 | 30.00 | 0.81 | 0.91 | 0.99 | 29.8 | 23.9 | | | | | |
| 12 | AS 230E | Crane oil recirculation agitator | | | | | 27.14 | 30.00 | 0.81 | 0.91 | 0.99 | 29.8 | 23.9 | | | | | |
| 13 | AS 2310 | LV oil recirculation agitator | | | | | 9.99 | 11.00 | 0.93 | 0.93 | 0.99 | 11.93 | 10.96 | | | | | |
| 14 | AS 2310 | LV oil recirculation agitator | | | | | 9.99 | 11.00 | 0.93 | 0.93 | 0.99 | 11.93 | 10.96 | | | | | |
| 15 | AS 2314 | Crane Automatic Tank Agitator | | | | | 17.39 | 18.00 | 0.94 | 0.86 | 0.99 | 20.35 | 19.95 | | | | | |
| Maximum of normal running plant load : | | | | | | | 493.5 kW | 377.2 kVAR | kVAr (kW² + kVAR²) = | | TOTAL | 493.50 | 372.52 | | | 147.51 | 108.03 | |
| Peak Load (Est. kW + ykW) | | | | | | | 613.3 kW | 388.0 kVAR | kVAr (kW² + kVAR²) = | | kVA | 613.31 | | 22.87 | | | 162.92 | |
| Assumptions | | | | | | | | | | | | | | | | | | |
| 1) Load factor, Efficiency and Power factor: | | | | | | | | | | | | | | | | | | |
| Load factor (kW) | | | | | | | Efficiency | | | | | | | Power factor | | | | |
| = 0.8 | | | | | | | = 0.8 | | | | | | | = 0.9 | | | | |
| = 0.8 | | | | | | | = 0.8 | | | | | | | = 0.8 | | | | |
| = 0.8 | | | | | | | = 0.8 | | | | | | | = 0.8 | | | | |
| = 0.8 | | | | | | | = 0.8 | | | | | | | = 0.8 | | | | |
| 2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for continuous, 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 : | | | | | | | | | | | | |
| a. Continuous load | | | | | | | | | | | | |
| b. Intermittent load / Diversity Factor | | | | | | | | | | | | |
| c. Stand-by load required as consumed load | | | | | | | | | | | | |
| Max. Consumed load = ((I) + 30% (II) + 10% (III)) = | | | | | | | | | | | | |
| Future expansion load (20% capacity) | | | | | | | | | | | | |
| Total Load = | | | | | | | | | | | | |
| 1.2 Calculation for 3.3kV / 0.433 kV transformer capacity | | | | | | | | | | | | |
| Max. Consumed load | | | | | | | | | | | | |
| Spare capacity | | | | | | | | | | | | |
| Required capacity | | | | | | | | | | | | |
| Transformer rated capacity | | | | | | | | | | | | |
| 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 _v = | | | | | | | | | | | | |
| Hence, %R = | | | | | | | | | | | | |
| %X = | | | | | | | | | | | | |
| P _v = | | | | | | | | | | | | |
| P _s = | | | | | | | | | | | | |
| Cos θ _s = 0.25, corresponding to Angle θ _s = | | | | | | | | | | | | |
| P _s = | | | | | | | | | | | | |
| Cos θ _s = 0.65, corresponding to Angle θ _s = | | | | | | | | | | | | |
| P _v = | | | | | | | | | | | | |
| P _s = | | | | | | | | | | | | |
| Cos θ _s = | | | | | | | | | | | | |
| Voltage Regulation = | | | | | | | | | | | | |
| Result: During starting of max. capacity motor, while all other loads are running, the voltage regulation at Transformer secondary terminals is approx. 6.5%, which meets the criteria to maintain less than 15% voltage regulation. | | | | | | | | | | | | |
| 1.4 Selection of rated capacity | | | | | | | | | | | | |
| 750 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 Voltage | 415 | KV |
| Power factor (Cos ϕ) | 0.764 | Avg |
| Efficiency | 0.88 | Avg |
| Total operating load on DG set in KVA at 0.764 power factor | 625.2 | |
| Largest motor to start in the sequence - load in KW | 115 | KW |
| Running KVA of last motor (Cos ϕ = 0.91) | 171 | 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) | 1026 | KVA |
| Base load of DG set in KVA (Total operating load in KVA – Running KVA of last motor) | 454 | KVA |
| A. Continuous operation under load -P1 | | |
| Capacity of DG set based on continuous operation under load P1 | 454 | 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 | 1480 | KVA |
| Subtransient Reactance of Generator (X_d'') | 7.91% | (Assumed) |
| Transient Reactance of Generator (X_d') | 10.065% | (Assumed) |
| $X_d''' = (X_d'' + X_d')/2$ | 0.089873 | |
| Transient Voltage Dip | 15% | (Max) |
| Transient Voltage dip during Soft starter starting of Last motor $P2 = \text{Total momentary load in KVA} \times X_d''' \times (1 - \text{Transient Voltage Dip})$ (Transient Voltage Dip) | 754 | KVA |
| C. Overload capacity P3 | | |
| Capacity of DG set required considering overload capacity | | |
| Total momentary load in KVA | 1480 | KVA |
| overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2) | 150% | |
| Capacity of DG set required considering overload capacity (P3) = $\frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$ | 987 | KVA |
| Considering the last value amongst P1, P2 and P3 | | |
| Continuous operation under load -P1 | 454 | KVA |
| Transient Voltage dip during Soft starter starting of Last motor P2 | 754 | KVA |
| Overload capacity P3 | 987 | KVA |
| Considering the last value amongst P1, P2 and P3 | 987 | KVA |
| Hence, Existing Generator 987 KVA is adequate to cater the loads as per re-scheduled loads | | |
| 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

| | | |
|--|--|--------|
| Assignment 4 Earthing | | 2 |
| Maximum line-to-ground fault in kA for 1 sec | | 17 |
| Earthing material (Earth rod & earth strip) | | GI |
| Depth of earth flat burial in meter | | 0.5 |
| Average depth / length of Earth rod in meters | | 4.5 |
| Soil resistivity ρ -meter | | 7.5 |
| 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 | | |
| $I_{LG} = A_c \times \sqrt{\left[\frac{T.C.A.P \times 10^{-4}}{t_c \times \rho \times K_0 \times K_1} \right] \times \left[\frac{K_0 + T_m}{K_0 + T_a} \right]}$ | | |
| or - Thermal co-efficient of resistivity, at 20 oC | | 0.0032 |
| pr - Resistivity of ground conductor at 20 oC | | 20.10 |
| Ta - Ambient Temperature in °C | | 50 |
| I _{LG} - RMS fault current in kA = 50 KA | | 14 |
| tc - Short circuit current duration sec | | 1 |
| Thermal capacity factor, T.CAP J/(cm ³ .oC) | | 3.93 |
| Tm - Maximum allowable temperature for copper conductor, in oC | | 419 |
| K0 - Factor at oC | | 293 |
| The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod: | | |
| 14 = Ac * | | 0.123 |
| Ac - Required conductor cross section in sq.mm | | |
| 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 | | |
| $I_{LG} = A_c \times \sqrt{\left[\frac{T.C.A.P \times 10^{-4}}{t_c \times \rho \times K_0 \times K_1} \right] \times \left[\frac{K_0 + T_m}{K_0 + T_a} \right]}$ | | |
| or - Thermal co-efficient of resistivity, at 20 oC | | 0.0032 |
| pr - Resistivity of ground conductor at 20 oC | | 20.10 |
| Ta - Ambient Temperature in °C | | 50 |
| I _{LG} - RMS fault current in kA = 50 KA | | 14 |
| tc - Short circuit current duration sec | | 1 |
| Thermal capacity factor, T.CAP J/(cm ³ .oC) | | 3.93 |
| Tm - Maximum allowable temperature for copper conductor, in oC | | 419 |
| K0 - Factor at oC | | 293 |
| The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod: | | |
| 14 = Ac * | | 0.123 |

| | | |
|--|--|---|
| Assignment 5 | | 1 |
| Location | | Bhambam |
| Building | | Concrete, Industrial |
| Type of Building | | Flat Roofs (a) |
| Building Length (L) | | 11 |
| Building breadth (W) | | 7 |
| Building Height (H) | | 9 |
| Risk Factor Calculation | | |
| 1 Collection Area (A _c) | | $= (L^2 \times W) + (2^2 \times L^2 \times H) + (2^2 \times W^2 \times H) + (3.14^2 \times H^2 \times H)$ 655.34 |
| 2 Probability of Being Struck (P) | | $= A_c \times N_b \times 10^{-6}$ 0.001245156 |
| 3 Overall weighting factor | | |
| a) Use of structure (A) | | 1.0 |
| b) Type of construction (B) | | 1.4 |
| c) Contents or consequential effects (C) | | 0.8 |
| d) Degree of isolation (D) | | 1.0 |
| e) Type of occupancy (E) | | 0.3 |
| W _{eq} - Overall weighting factor | | $= A \times B \times C \times D \times E$ 0.336 |
| 4 Overall Risk Factor | | $P \times W_{eq}$ 0.000418589 |
| As per clause no. 9.7 of IS-6651, suggested acceptable risk factor (Pe) has been taken as 10^{-3} | | |
| Since Pe > Pe lightning protection required. | | |
| 5 Air Terminations | | |
| Perimeter of the building | | $= 2(L+W)$ 38 mts. |
| 6 Down Conductors | | |
| Perimeter of building | | 38 |
| No. of down conductors based on perimeter | | 2 |
| Hence 2 nos. of Down conductors have been selected. | | |
| Size of Down conductor | | 20 X 2.5 mm Galvanized Steel Strip |
| (As per IS6651, 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) | | |

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.

This is a screenshot of a spreadsheet used for cable sizing calculations. It contains multiple columns with headers such as 'Cable Type', 'Cable Size', 'Length', 'Current', 'Voltage', 'Power', 'Losses', and 'Remarks'. The data is organized in rows, with some cells highlighted in blue and green. The spreadsheet appears to be a detailed calculation tool for determining the appropriate cable size based on various electrical and physical parameters.

This is a screenshot of a spreadsheet used for cable tray sizing calculations. It contains multiple columns with headers such as 'Cable Type', 'Cable Size', 'Length', 'Current', 'Voltage', 'Power', 'Losses', and 'Remarks'. The data is organized in rows, with some cells highlighted in blue and green. The spreadsheet appears to be a detailed calculation tool for determining the appropriate cable tray size based on various electrical and physical parameters.

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

[illegible]

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 | 493.5 | 372.5 | 618.31 | --- (i) |
| b. Intermittent load / Diversity Factor | 16.76 | 15.7 | 22.96 | --- (ii) |
| c. Stand-by load required as consumed load | 147.61 | 108.0 | 182.92 | --- (iii) |
| Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) = | 513.3 | 388.0 | 643.46 | |
| Future expansion load (20% capacity) | 102.7 | 77.6 | 128.69 | |
| Total Load = | 615.9 | 465.6 | 772.15 | |

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

| | | |
|----------------------------|---|-----------|
| Max. Consumed load | = | 643.5 kVA |
| Spare capacity | = | 128.7 kVA |
| Required capacity | = | 772.1 kVA |
| Transformer rated capacity | = | 750 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 : $P_r =$

$$750 \text{ KVA} \quad (\%Z) = 5.19 \text{ \& Ratio } X/R = 5.4$$

$$\text{Hence , } \%R = 0.941 \%$$

$$\%X = 5.10 \%$$

$$P_M = 110 \text{ KW having (K = 6 \& C = 1 \& Cos } \theta = 0.82 \text{ \& Eff. } = 0.93 \text{ \& Cos } \phi = 0.25$$

$$P_s = 865.46 \text{ KVA}$$

$$\text{Cos } \theta_s = 0.25, \text{Corresponding to Angle } \theta_s = 75.5225 \text{ Degrees for which Sin } \theta_s = 0.97$$

$$P_B = 405 \text{ KVA \& PB in KW is 344.25 \& } P_B \text{ in Kvar = 202.5 \& Cos } \theta_B = 0.850$$

$$\text{Cos } \theta_B = 0.85, \text{Corresponding to Angle } \theta_B = 31.7883 \text{ Degrees, for which Sin } \theta_B = 0.53$$

$$P_{CP} = 560.615 \text{ KW}$$

$$P_{CQ} = 1040.48 \text{ KVAR}$$

$$P_C = 1181.9 \text{ KVA}$$

$$\text{Cos } \theta_C = 0.47433, \text{ where as Sin } \theta_C = 0.880$$

$$\text{Voltage Regulation } \square = 7.8 \%$$

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx. 6.5% , which meets the criteria to maintain less than 15% voltage regulation.

1.4 Selection of rated capacity

750 kVA transformer selected.

Assignment 3

DG SIZING CALCULATIONS

Design Data

| | | |
|--|-------|---|
| Rated Voltage | 415 | KV |
| Power factor (CosØ) | 0.764 | Avg |
| Efficiency | 0.88 | Avg |
| Total operating load on DG set in kVA at 0.764 power factor | 625.2 | |
| Largest motor to start in the sequence - load in KW | 115 | KW |
| Running kVA of last motor (CosØ= 0.91) | 171 | 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) | 1026 | KVA |
| Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor) | 454 | KVA |

A Continuous operation under load -P1

| | | |
|--|-----|-----|
| Capacity of DG set based on continuous operation under load P1 | 454 | 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) | 1480 | KVA |
| Subtransient Reactance of Generator (Xd'') | 7.91% | (Assumed) |
| Transient Reactance of Generator (Xd') | 10.065% | (Assumed) |
| $X_d''' = (X_d'' + X_d')/2$ | 0.089875 | |
| Transient Voltage Dip | 15% | (Max) |
| Transient Voltage dip during Soft starter starting of Last motor $P2 = \text{Total momentary load in KVA} \times X_d''' \times \frac{(1 - \text{Transient Voltage Dip})}{(\text{Transient Voltage Dip})}$ | 754 | KVA |

C Overload capacity P3

| | | |
|--|------|-----|
| Capacity of DG set required considering overload capacity | | |
| Total momentary load in KVA | 1480 | KVA |
| overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2) | 150% | |
| Capacity of DG set required considering overload capacity (P3) = $\frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$ | 987 | KVA |
| Considering the last value amongst P1, P2 and P3 | | |
| Continuous operation under load -P1 | 454 | KVA |
| Transient Voltage dip during Soft starter starting of Last motor P2 | 754 | KVA |
| Overload capacity P3 | 987 | KVA |
| Considering the last value amongst P1, P2 and P3 | 987 | KVA |

Hence, Existing Generator 987 KVA is adequate to cater the loads as per re-scheduled loads

NOTE: VOLTAGE DIP CONSIDERED - 15%

Assignment 4

Earthing

2

| | | |
|---|-----|-----|
| Maximum line-to-ground fault in kA for 1 sec | 17 | |
| Earthing material (Earth rod & earth strip) | GI | |
| Depth of earth flat burial in meter | 0.5 | |
| Average depth / length of Earth rod in meters | 4.5 | |
| Soil resistivity Ω-meter | 7.5 | |
| 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

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

| | |
|--|--------|
| αr - Thermal co-efficient of resistivity, at 20 oC | 0.0032 |
| ρr - Resistivity of ground conductor at 20 oC | 20.10 |
| Ta - Ambient Temperature is °C | 50 |
| Ilg - 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

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

| | |
|--|--------|
| αr - Thermal co-efficient of resistivity, at 20 oC | 0.0032 |
| ρr - Resistivity of ground conductor at 20 oC | 20.10 |
| Ta - Ambient Temperature is °C | 50 |
| Ilg - 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 flat area in mm | 12 |
| Earth flat area (including 25% corrosion allowance) in mm | 15 |
| Selected flat size W * Thk in sq mm | 20 |

R_g - Grid resistance

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

| | |
|--|-------|
| ρ - Soil resistivity in Ω -meter= | 7.5 |
| 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 |

R_g - Grid resistance 0.048

R_r - Earth Electrode resistance

Grid resistance can be calculated using Eq. 55 of IEEE

$$R_r = \frac{\rho}{2 \times \pi \times n_r \times L_r} \left[1 + \frac{4 \times L_r}{b} \right] + \frac{2 \times k_l \times L_r}{\sqrt{A}} \left[\pi - 1 \right]$$

| | |
|---|-------|
| ρ - Soil resistivity in Ω -meter, 16.96 | 7.5 |
| n - No of earth electrodes | 6 |
| L_r - Length of earth electrode in meter | 4.5 |
| b - Diameter of earth electrode in meter | 0.020 |
| k_l - co-efficient | 1 |
| A - Area of grid in square metre | 11200 |

R_r - Earth Electrode resistance 2.75561

Grounding system resistance

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

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

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

R_s - Total earthing system resistance 0.048 Ohms

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

Assignment 5

| | |
|----------------------|----------------------|
| | 1 |
| Location | Khammam |
| Building | Concrete, Industrial |
| Type of Building | Flat Roofs (a) |
| Building Length (L) | 11 |
| Building breadth (W) | 7 |
| Building Height (H) | 9 |

Risk Factor

Calculation1 Collection

Area (A_c)

$$A_c = \frac{(L*W) + (2*L*H) + (2*W*H) + (3.14*H*H)}{655.34}$$

2 Probability of Being Struck (P)

$$P = \frac{A_c * N_g * 10^{-6}}{0.001245146}$$

3 Overall weighing factor

| | | |
|--|---|---------------------|
| a) Use of structure (A) | = | 1.0 |
| b) Type of construction (B) | = | 1.4 |
| 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 | = | $A * B * C * D * E$ |
| | = | 0.336 |

4 Overall Risk Factor

| | | |
|----|---|-------------|
| Po | = | $P * Wo$ |
| Po | = | 0.000418369 |
| 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 | = | $2(L+W)$ | Mts. |
| | = | 36 | |

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 -6

| S.NO. | 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 Starting | SIN Φ Starting | 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 | PU2315 | Silica filter feed pump | 101.41 | 110.00 | 415 | 3 | 176.4 | 1058.15 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 70 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 95 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20 |
| 4 | PU 2314-A | Absorbesnt/Neutral oil pump (W) | 29.46 | 30.00 | 415 | 3 | 51.2 | 307.40 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 16 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 95 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 5 | PU 2314 -B | Absorbesnt/Neutral oil pump (S) | 25.33 | 30.00 | 415 | 3 | 44.1 | 264.30 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 10 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 60 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 6 | PU2305 | Feed Pump (Sperator) | 102.42 | 110.00 | 415 | 3 | 178.1 | 1068.69 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 70 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 85 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 7 | MX2305 | MIXER (W) | 103.21 | 110.00 | 415 | 3 | 179.5 | 1076.93 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 50 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 75 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 8 | MX 2308 | MIXER (S) | 103.21 | 110.00 | 415 | 3 | 179.5 | 1076.93 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 70 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 105 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 9 | BW2313 | Blower | 44.31 | 45.00 | 415 | 3 | 77.1 | 462.35 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 35 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 100 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 10 | Rotary valve | TK 2313B (I) | 4.30 | 4.70 | 415 | 3 | 7.5 | 44.87 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 4 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 100 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 11 | SC2314 | Screw conveyor (I) | 9.95 | 11.00 | 415 | 3 | 17.3 | 103.82 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 6 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 75 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20 |
| 12 | AG 2324A | Citric acid tan agitator (W) | 7.48 | 7.50 | 415 | 3 | 13.0 | 78.05 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 6 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 110 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 13 | AG 2324B | Citric acid tank agitator (S) | 7.48 | 7.50 | 415 | 3 | 13.0 | 78.05 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 6 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 75 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20 |
| 14 | AG 2305 | Citric oil rection vessel agitator | 27.17 | 30.00 | 415 | 3 | 47.3 | 283.50 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 25 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 105 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20 |
| 15 | AG 2309 | Lye oil reaction vessel agitator | 9.89 | 11.00 | 415 | 3 | 17.2 | 103.20 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 25 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 85 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 32 |
| 16 | AG 2310 | Lye oil reaction vessel agitator | 9.89 | 11.00 | 415 | 3 | 17.2 | 103.20 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 35 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 95 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| 17 | AG 2314 | Soap Adsorbant Tank Agitator | 17.30 | 18.50 | 415 | 3 | 30.1 | 180.51 | 0.8 | 0.6 | 0.8 | 0.5 | 2 | 1 | 4.0 | 10 | #REF! | 0.98 | 0.9 | 1 | 1 | 0.882 | #REF! | 65 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | 20s |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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Basis:

1. Overall derating factor $k = k_1 \times k_2 \times k_3 \times k_4$
 - 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 $\pm 5\%$
5. Combined Effect of Voltage & Frequency Variation $\pm 10\%$

LT CABLES**CABLE TRAY: FROM**

| | | LT-4 | | TO | LT-5 | | | | |
|---------|-----------------------|-------------------|----------------------------------|--------------|-------------------------------------|----------------------|------------------------------|-------------------------------|---------|
| Sr. No. | Cable Route (From-To) | Type & Cable Size | Size of Cable (mm ²) | No. of Cable | Overall Diameter of each Cable (mm) | Sum of Cable OD (mm) | Self Weight of Cable (Kg/Mt) | Total Weight of Cable (Kg/Mt) | Remarks |
| 1 | PU2315 | 4.0 | 70 | 1 | 29 | 29 | 3.25 | 3.25 | |
| 2 | PU 2314-A | 4.0 | 16 | 1 | 21 | 21 | 1 | 1 | |
| 3 | PU 2314 -B | 4.0 | 10 | 1 | 18 | 18 | 0.9 | 0.9 | |
| 4 | PU2305 | 4.0 | 70 | 1 | 29 | 29 | 3.25 | 3.25 | |
| 5 | MX2305 | 4.0 | 50 | 1 | 26 | 26 | 2.3 | 2.3 | |
| 6 | MX 2308 | 4.0 | 70 | 1 | 29 | 29 | 3.25 | 3.25 | |
| 7 | BW2313 | 4.0 | 35 | 1 | 24 | 24 | 1.8 | 1.8 | |
| 8 | Rotary valve | 4.0 | 4 | 1 | 17 | 17 | 0.6 | 0.6 | |
| 9 | SC2314 | 4.0 | 6 | 1 | 18 | 18 | 0.7 | 0.7 | |
| 10 | AG 2324A | 4.0 | 6 | 1 | 18 | 18 | 0.7 | 0.7 | |
| 11 | AG 2324B | 4.0 | 6 | 1 | 18 | 18 | 0.7 | 0.7 | |
| 12 | AG 2305 | 4.0 | 25 | 1 | 22 | 22 | 1.4 | 1.4 | |
| 13 | AG 2309 | 4.0 | 25 | 1 | 22 | 22 | 1.4 | 1.4 | |
| 14 | AG 2310 | 4.0 | 35 | 1 | 24 | 24 | 1.8 | 1.8 | |
| 15 | AG 2314 | 4.0 | 10 | 1 | 18 | 18 | 0.9 | 0.9 | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| Total | | | | | | | | | |

Calculation

| | | |
|--|--------|----------|
| Maximum Cable Diameter: | 70 | mm |
| Consider Spare Capacity of Cable Tray: | 30% | |
| Distance between each Cable: | 0 | mm |
| Calculated Width of Cable Tray: | 0 | mm |
| Calculated Area of Cable Tray: | 0 | 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 | 100% | |
| Cable Tray Area Remaning: | 100% | |