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INSTITUTE OF
TECHNOLOGY

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Internal Assesment Test –I

Sub:	ELECTRICAL DISTRIBUTION SYSTEMS							Code:	10EE844
Date:	16/ 04/ 2018	Duration:	90 mins	Max Marks:	50	Sem:	8th	Branch:	EEE

Answer any FIVE questions. Sketch figures as necessary.

		Marks	OBE	
			CO	RBT
1 a	Explain different components of planning process	05	CO1	L4
1 b	Write a note on distributed generation	05	CO1	L2
2 a	With block diagram ,explain the process of digital mapping	04	CO6	L4
2 b	Explain engineering design with flow diagram of design process	06	CO4	L4
3	Explain distribution substation with i) single bus sub station ii) Ring or mesh sub station	10	CO3	L4
4	Discuss about demand side management and its benefits	10	CO3	L2
5	Explain the feeder system with circuit diagram in distribution system	10	CO4	L4
6 a	Discuss the importance of voltage control on power utility system	07	CO5	L2
6 b	Write briefly about the operation criteria in distribution system	03	CO5	L2
7 a	Discuss in brief the planning criteria & standards of distribution system	08	CO1	L2
7 b	Write a note on GPS	02	CO6	L2

******All the Best*****

Solution

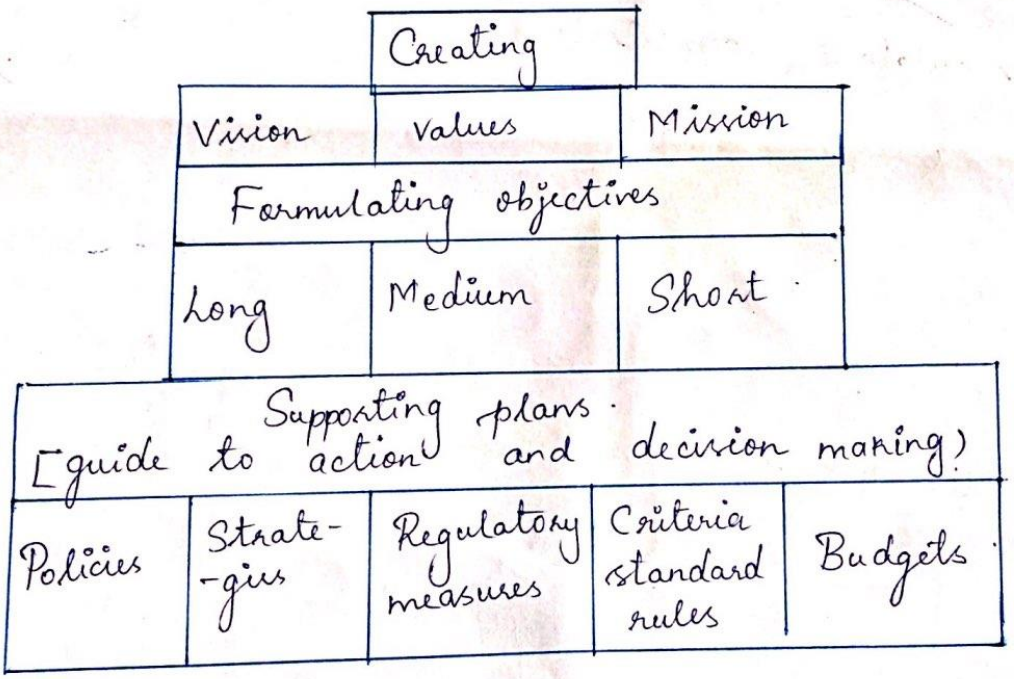
1(a).

Planning Process:

Planning - process of taking careful decision.

The objective of DS planning - provide satisfactory service at lowest possible cost

The components of planning process are shown in the figure below,



Planning process is driven by two i/ps - long-te planning and short-term planning.

→ Vision – the art of seeing things which are invisible

→ Mission – for a particular task there can be a mission statement.

eg: Electricity for all in India by 2020.

→ Values : power utility should create values such as consumer satisfaction, environmental responsibility, service culture etc for the consumers.

→ Objectives – state the need to be achieved.

→ Strategy – Think – plan – deliver – review.

→ Regulatory measures are taken by central and state regulatory commissions.

The following steps are involved in the planning process:

i) Feasibility studies are carried out

define the problem – find the alternative – evaluate the alternatives – select the best one.

ii) Detailed project report (for long, medium & short term plans) is prepared.

iii) Final approval is done after financial and economic appraisal.

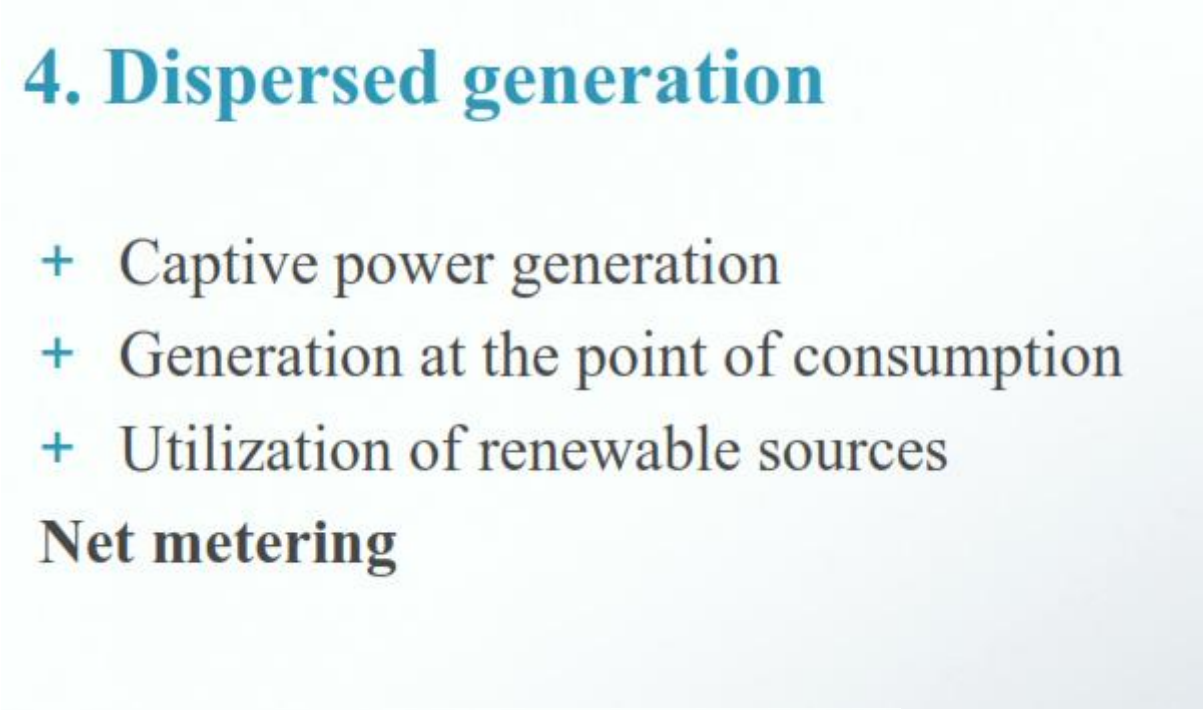
iv) Once best plan is selected, the next process of implementation begins.

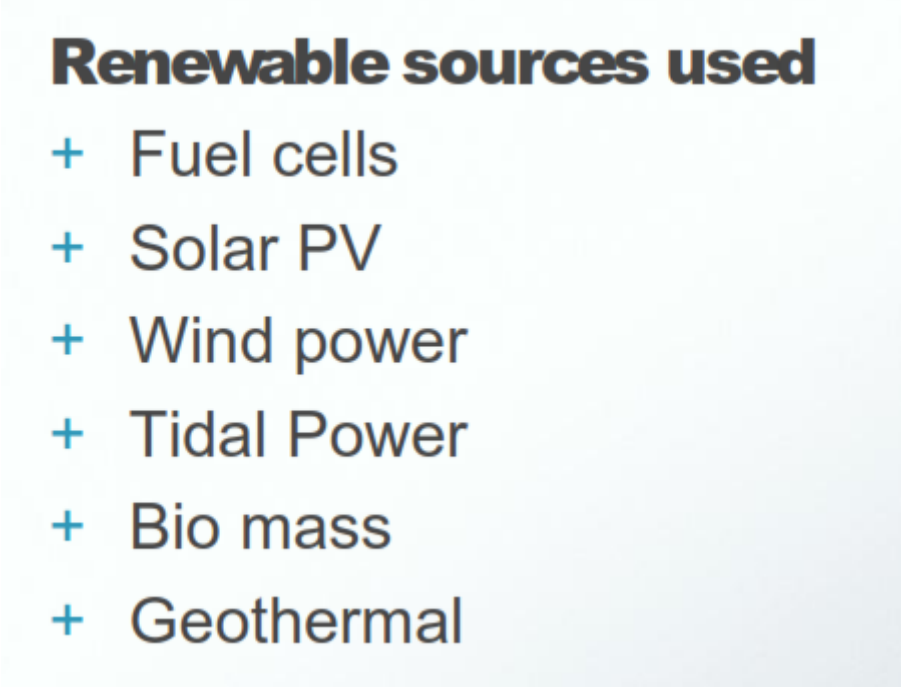
1(b).

It is the process of placing generating plants using renewable sources as their source of production near to the consumers to avoid overloading on main grid and maintain peak load demand from grid to run smoothly and to reduce transmission losses.

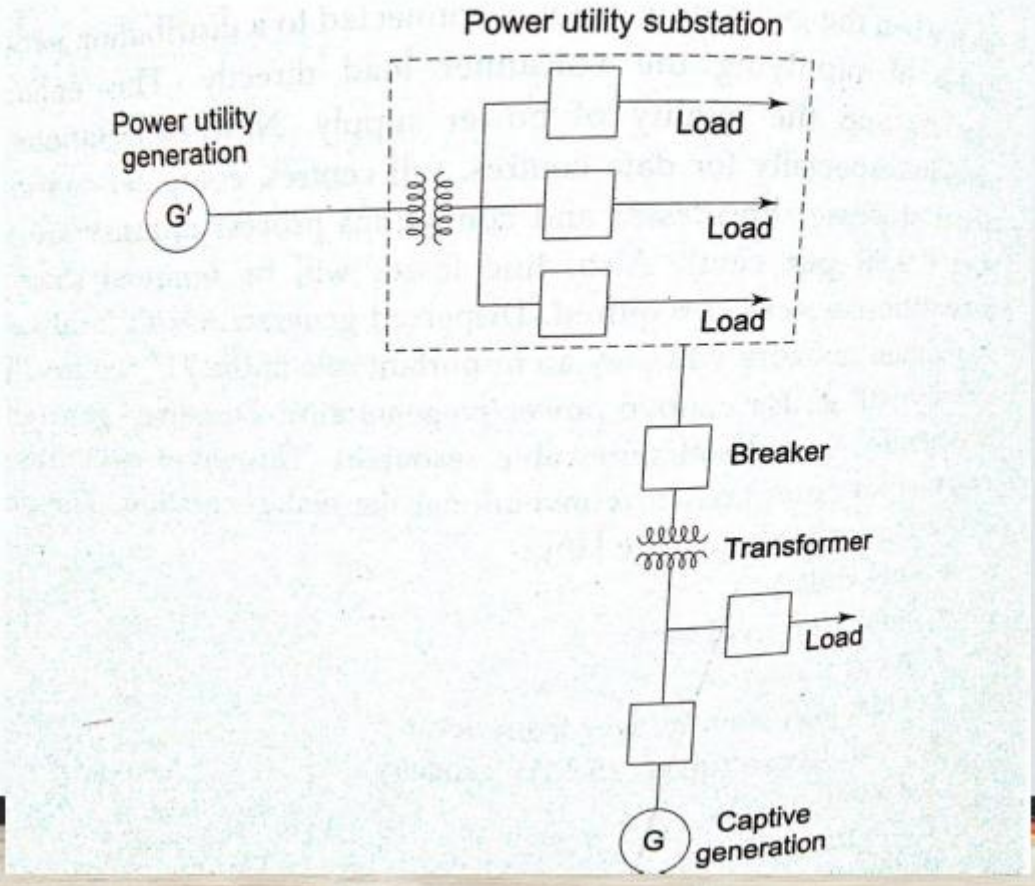
It also encourages consumers to give back the extra power generated by the consumers to main grid.

Government also gives subsidies to consumers who generate power using renewable sources





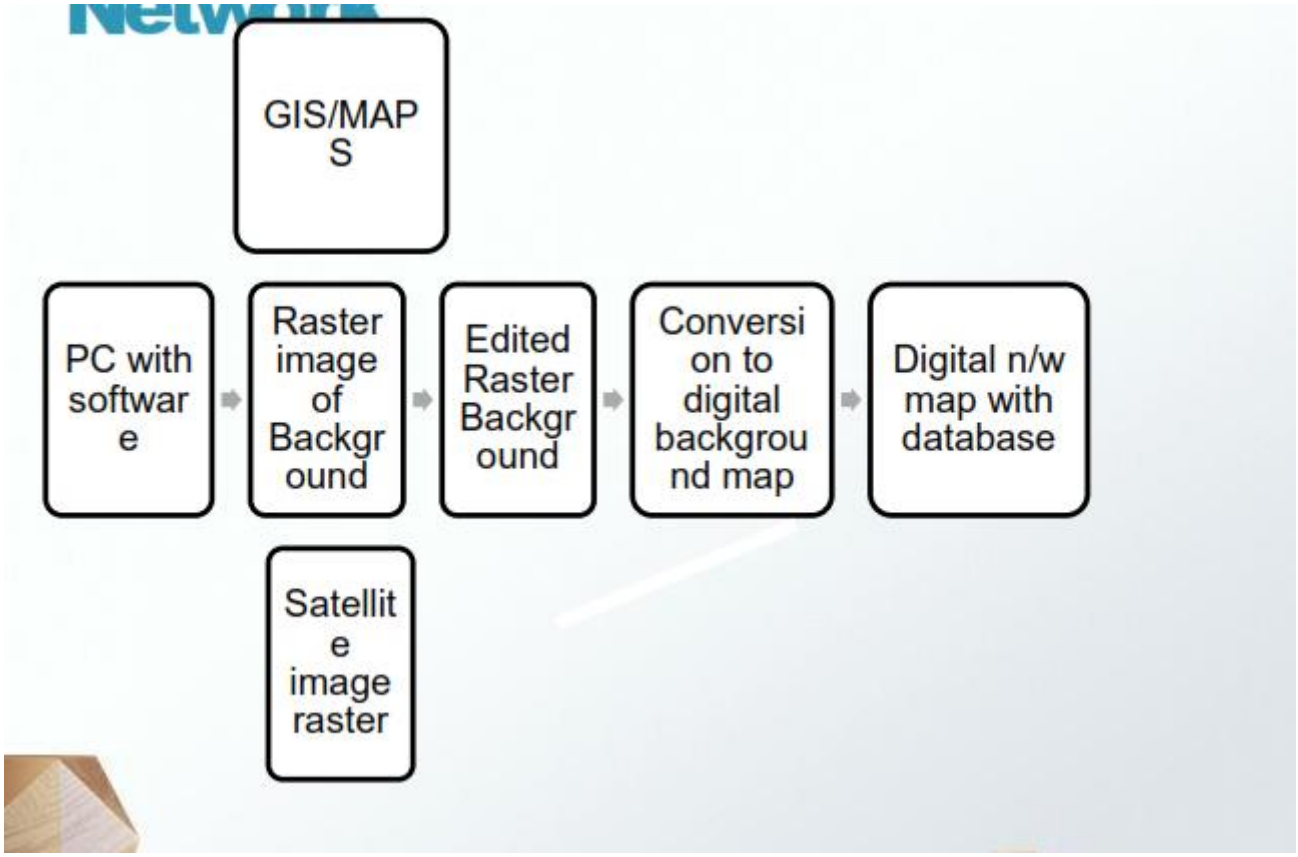
Captive power supply to grid



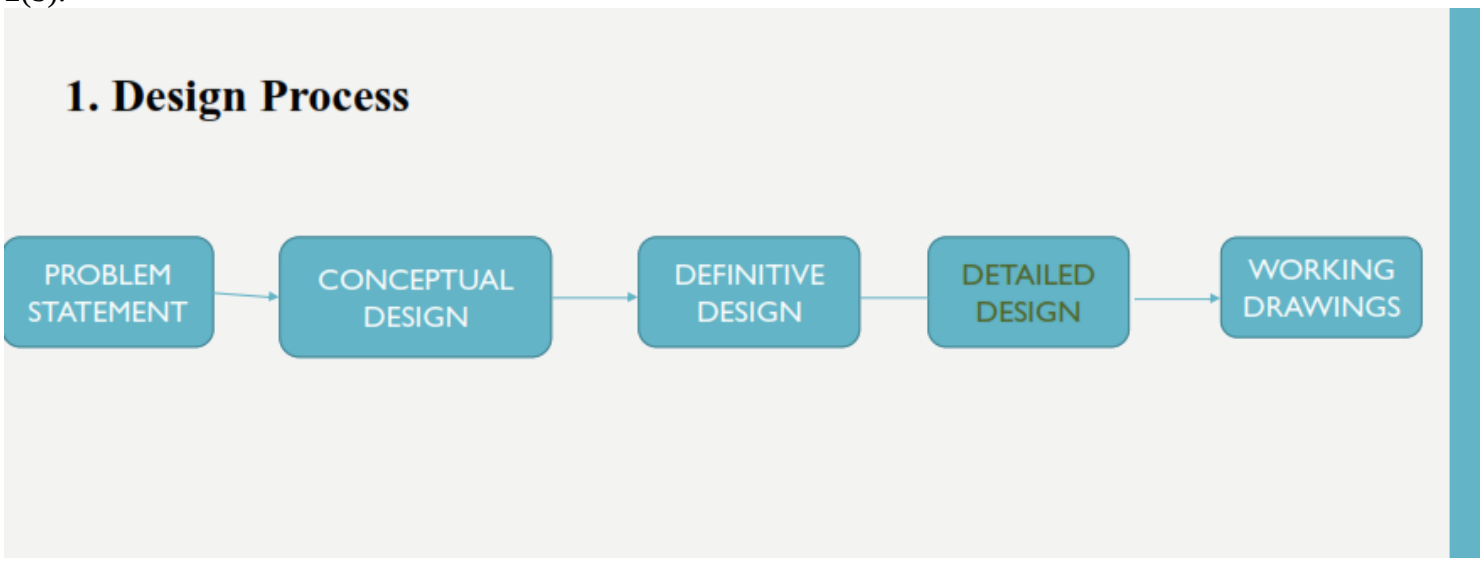
2(a).

Digital Mapping

+ Paper maps are **digitized and linked**
+ Once digitization is completed – software numbers the node – draws **network diagram** – calculates the length
+ Computer processing center issues prescribed format - data of **feeders, transformer capacity, size ,type**


GIS/MAPS
PC with software
Raster image of Background
Edited Raster Background
Conversion to digital background map
Digital n/w map with database
Satellite image raster

2(b).


1. Design Process
PROBLEM STATEMENT
CONCEPTUAL DESIGN
DEFINITIVE DESIGN
DETAILED DESIGN
WORKING DRAWINGS

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Problem Statement :-

→ Definition of the problem - simple and clear

Conceptual design :-

→ principles, ideas and alternatives

Definitive design :-

→ evaluation of scheme from alternative design schemes.

→ each alternative design will have its own strength and weaknesses which has to be compared and evaluated to determine the best solution.

Detailed design :

determining equipment size, specifications, costs, quality and reliability (actual engineering process).

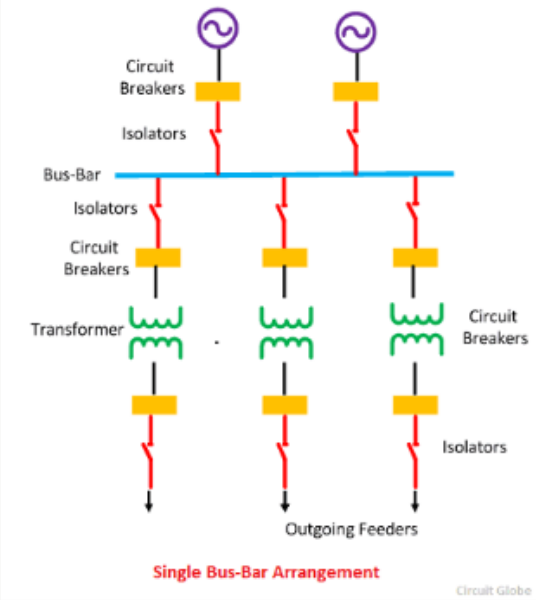
Layouts :-

working drawings.

3.

i)

TYPES OF BUS BARS



Single Bus-Bar Arrangement

- ***SINGLE BUS BAR SCHEME***
- **Advantage** –Lowest cost

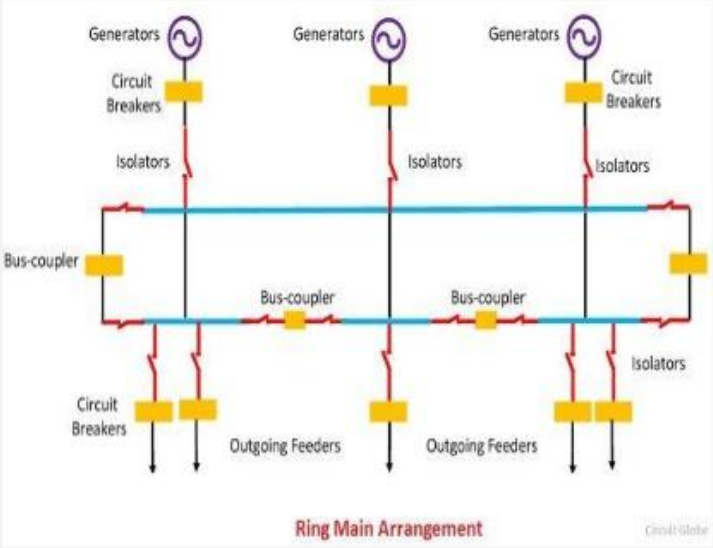
- **Disadvantage:**

Maintenance without interruption of supply is not possible.

Sub station can not be extended without completely de-energizing the sub station

Can be used only where loads can be interrupted or have other supply arrangements. Least flexibility.

ii)



Ring Main Arrangement

- During breaker maintenance, the ring is broken, but all lines remain in service.
- It is common practice to build major sub stations initially as a ring bus; for more than five outgoing circuits, the ring bus is usually developed to the breaker-and-a-half scheme.

4.

Demand side planning (DSP)

Introduction

- ***Electric Power Research Institute (EPRI)*** in the 1980s
- Also known as ***Energy Demand Management***.
- The **modification of consumer demand** for energy through various methods such as **financial** incentives and **education.**
- ***'Scientific control of usage and demand of Electricity, for achieving better load factor and economy, by the Licensee/Supplier'.***

- The main goal of demand side management is to ***encourage the consumer to use less energy during peak hours***, or to move the time of ***energy use*** to ***off-peak times*** such as night time and weekends.
- **DSM** will not total energy consumption, but could be expected to ***reduce the need for investments in networks.***
- *We can use **energy storage units.***

- ***TOD*** (Time of Day) ***Metering*** and ***differential pricing***
- ***DSM*** programs have ***planning, implementing & monitoring activities of electrical utilities*** that will modify the level & pattern of electricity usage of consumers.
- ***Two principle activities*** of DSM- a) Load shifting & b) Energy efficiency & conservation program.

Benefits of DSM

Initiative from the consumer side is very important for successful DSM

- Reduces consumer bills
- Reduces need of new equipment
- Economic development
- Pollution is reduced

Benefits of DSM

Customer Benefits	Utility Benefits	Societal Benefits
Satisfy electricity demands	Lower cost of service	Reduce environmental degradation
Reduce / stabilize costs or electricity bill	Improve operating efficiency, Flexibility	Conserve resources
Maintain/improve lifestyle and productivity	Improve customer service	Protect global environment

Steps of DSM

+ Identify target
+ Develop programme design
+ Conducting cost effective screening
+ Prepare
+ Implement
+ Evaluate

5.

FEEDER SYSTEM

Feeder

Transmission line which transmit the electrical energy from the **generating station to different distributing sub-stations.**

Feeders in DS – radial – only one power flow between consumer and substation

Drawbacks – complete loss of power supply

Alternative

loop or ring main system – two paths b/w consumer and sub station

FEEDER SYSTEM

It consists of

Primary system

Secondary system

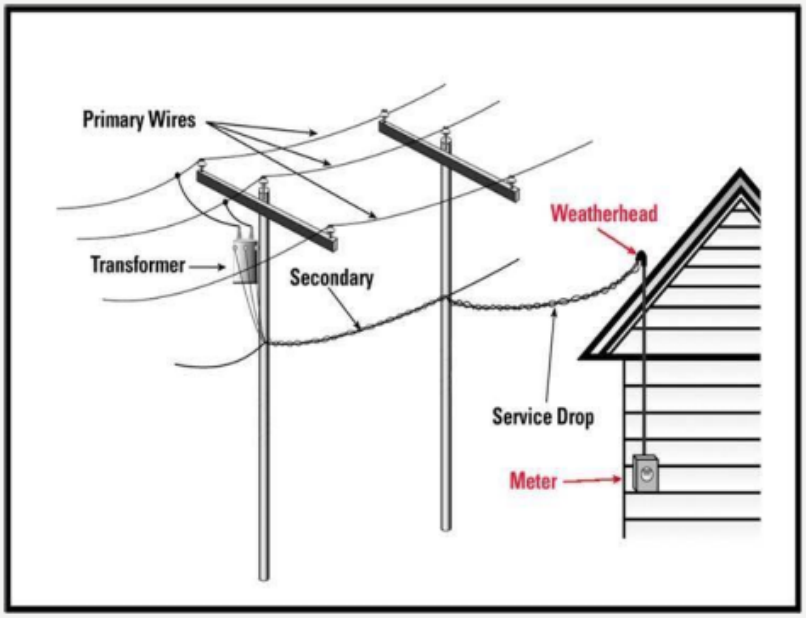
Service lines

Types of Feeders

Radial Feeder

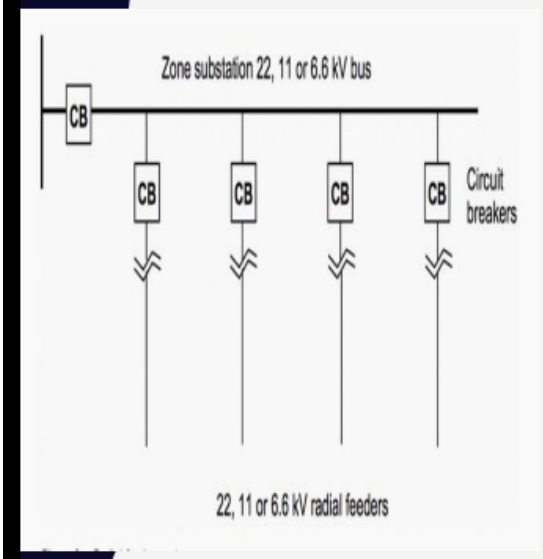
Parallel Feeder

Ring Main Feeder

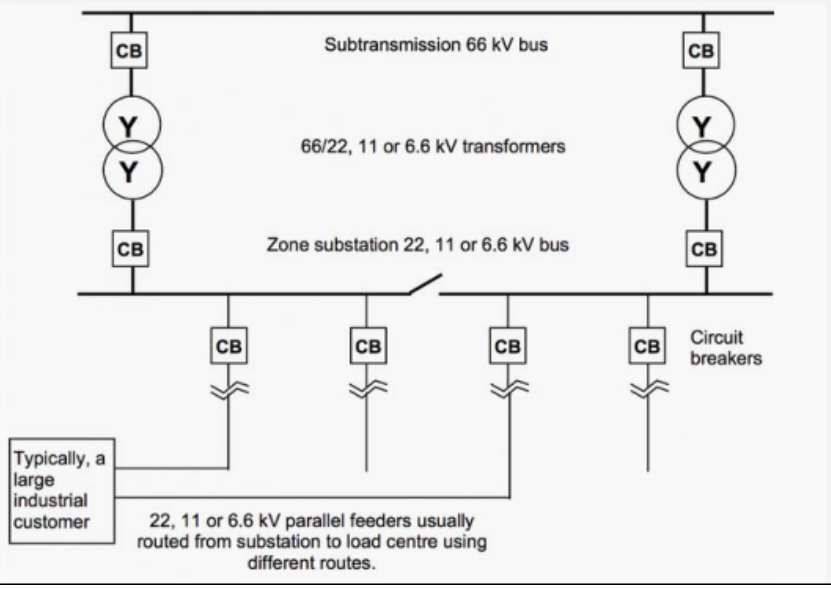


FEEDER SYSTEM

Radial feeder

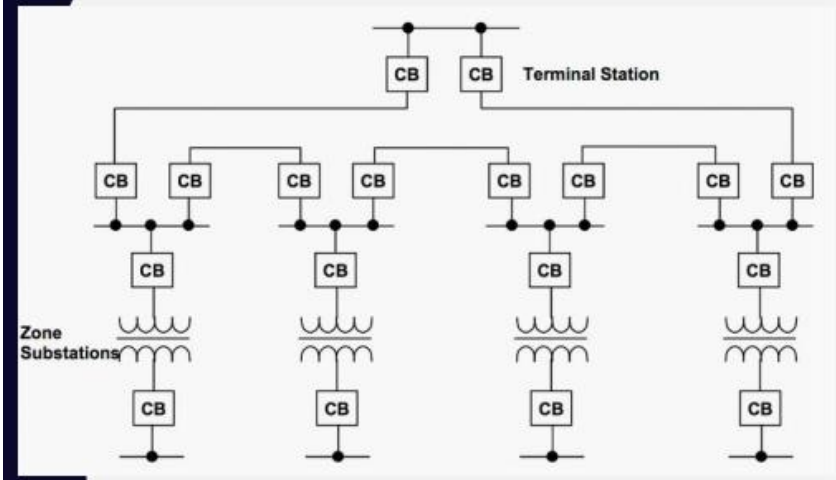


Parparallel feeder



FEEDER SYSTEM

Ring main feeder



Mesh system

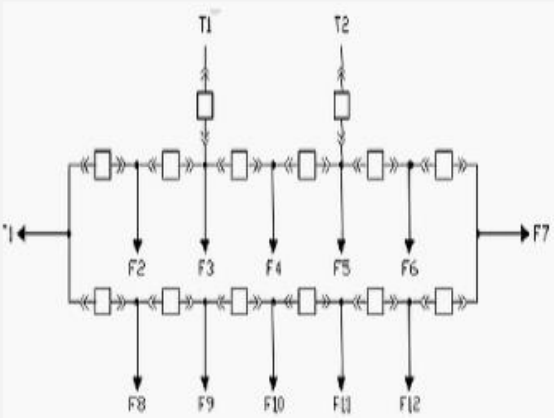


Figure 4 – Meshed systems

FEEDER SYSTEM

- Feeder rating depends on

Nature of load, area load density, load growth quality and continuity

- Feeder voltage level:

Voltage drop, feeder length

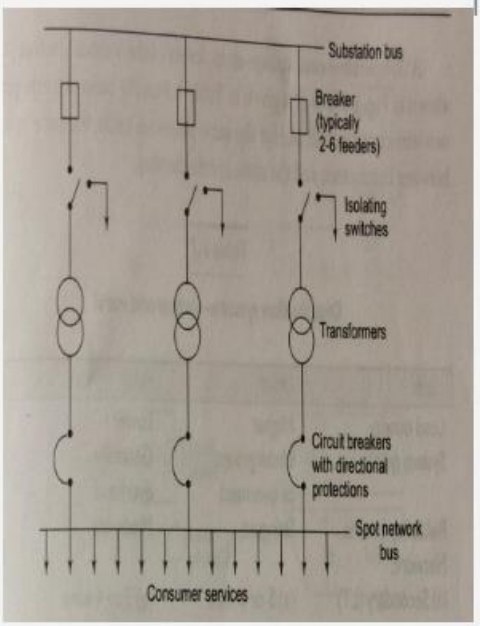
- **Primary systems-** 3-Ø with spur

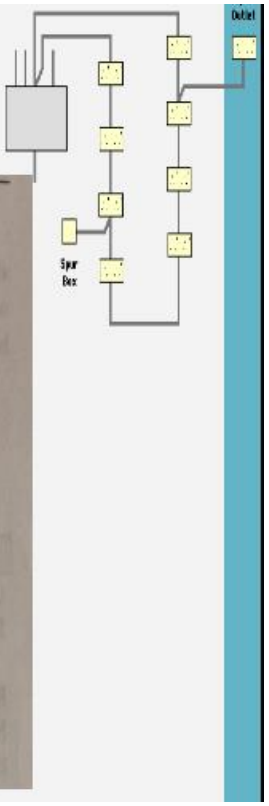
example: spot network

It has CBs

Voltage value can be increased by capacitors

spot network





FEEDER SYSTEM

- **Secondary systems-** secondary DS has step down DT, Consumer services and energy meters
- To minimize cost and secondary line length ??
- Considerations for secondary system
- Load losses in transformer secondary circuits, voltage drop voltage flicker, etc

Types of secondary system

- **Radial**
- **Parallel distribution transformers**: Improved voltage regulation, improved flexibility in accommodating load growth
- **Secondary network or grid** : suitable system for high load density (metropolitan cities)
- **Open ring main** : improved reliability

FEEDER SYSTEM

Service lines : Connection between LV network and consumer end

- Service lines are taken from nearest poles
- Not more that four service lines are taken from a support

6(a).

VOLTAGE CONTROL

For proper voltage control

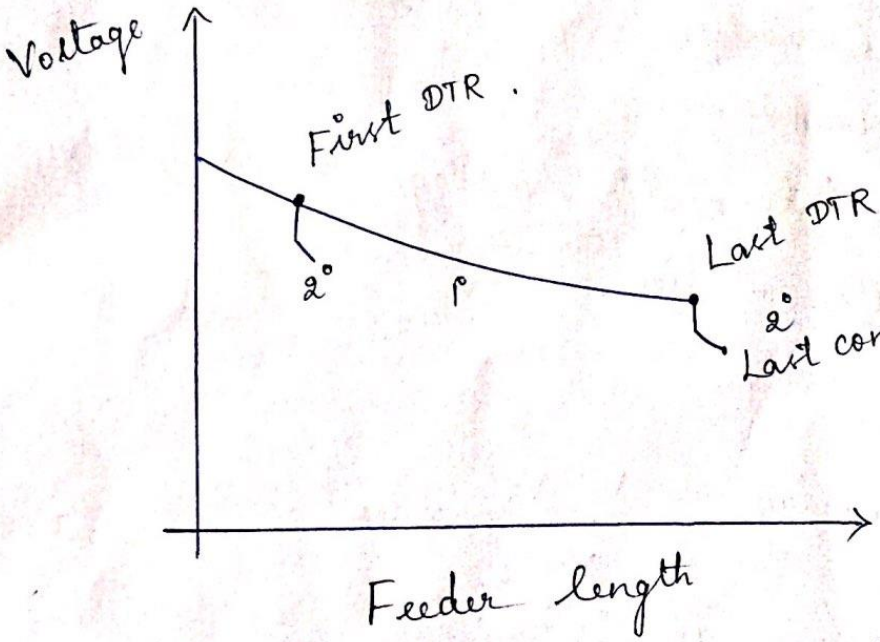
1. Regulation
2. kVA- km conductor loading
3. Voltage drop calculations
4. Correction of system voltage problems
5. Automatic voltage booster
6. computation

Imp

VOLTAGE CONTROL

All equipments designed to operate with certain voltage level. Voltage drop exists in each part of the system.

As a result, the last consumer on the DTR gets minimum value which is not desirable.



The maximum and min values for the consumer are specified in I.E Rules 1956.

→ Voltage drop and loss depend upon line impedance as well as loading.

→ ∴ Optimum conductor size is desirable.

For proper voltage control, the following things need to be taken care of.

* Regulation
* kVA - km conductor loading
* Voltage drop calculations
* Correction of system voltage problems
* Auto-matic voltage booster (AVB)
* Computation.

Voltage Regulation:

$$\%\text{ Regulation} = \frac{V_S - V_R}{V_R} \times 100.$$

V_S - sending end voltage

V_R - receiving end voltage.

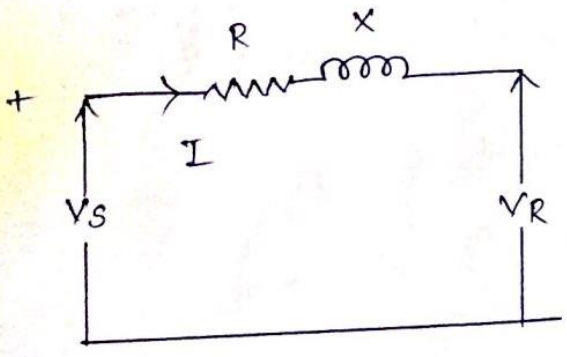
$$\%R = \left[\frac{IR\cos\phi + IX\sin\phi}{V_R}\right] \times 100.$$

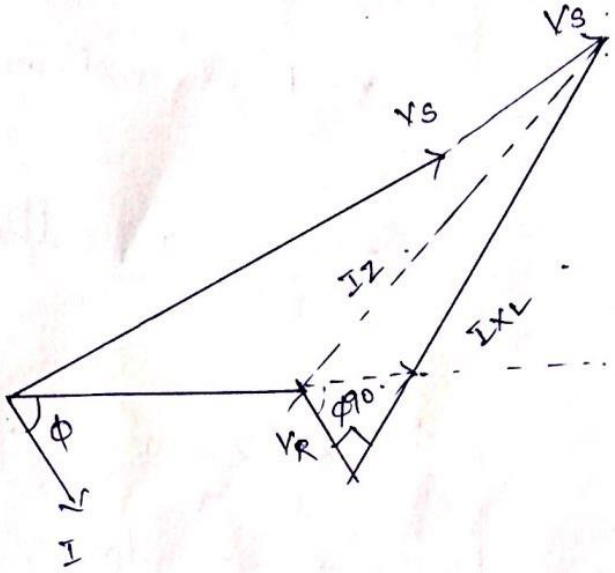
where I = line current

R = line resistance

ϕ = PF angle

X = line reactance.





$$V_S = V_R + IR\cos\phi + IX_L\sin\phi$$

$$V_S - V_R = IR\cos\phi + IX_L\sin\phi$$

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Voltage drop calculation :-

There are two methods for voltage drop calculation,

* First method → When max demand is not available.
* Second method → When max demand is available.

(i) * Primary feeder
* Secondary feeder.

Primary feeder :-

$$\text{Maximum demand} = \frac{\text{Sum of KVA ratings of DTRs}}{\text{Diversity factor}}$$

$$\% \text{ voltage drop} = \frac{\text{voltage drop / km.KVA} \times \text{total Km.KVA}}{\text{Diversity factor}}$$

Secondary feeder :-

voltage drop calculated based on consumer connected loads and consumer load diversity factor.

Thus distribution factor (= combination of type of load, demand factor and diversity factor) is used in the place of diversity factor.

ii) When maximum demand is available,

$$\text{Demand factor} = \frac{1.732 \times 11 \times \text{maximum demand}}{\text{Sum of KVA ratings of DTRs.}}$$

$$\% \text{ voltage drop} = \text{voltage drop per Km. KVA} \times \text{total Km.KVA} \times \text{demand factor.}$$

Correction of system voltage problems :-

The following ways can be adopted to improve the voltage regulation,

1 => Use of generator voltage regulators

2 => Application of voltage regulating equipment in the distribution sub-station

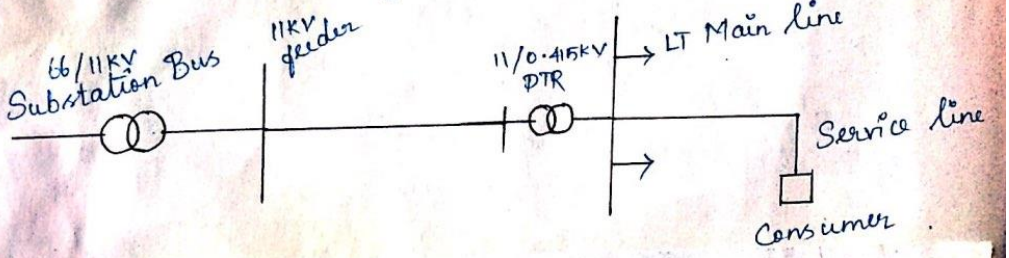
3 => Application of capacitors in the distribution sub-station.

4 => Balancing of loads on the primary feeders.

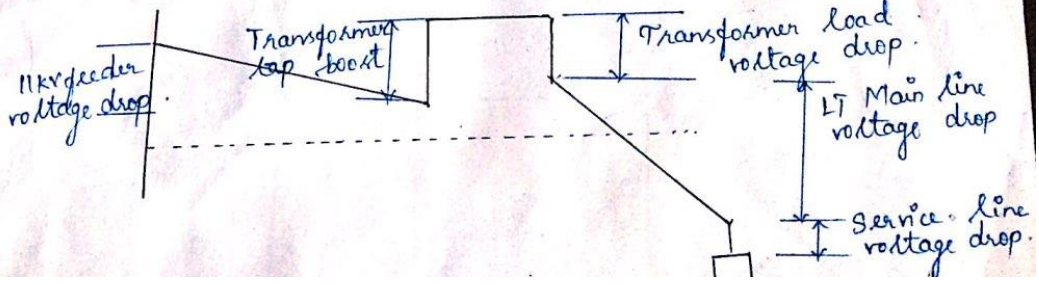
5 => increasing feeder conductor size.
6 => changing feeder sections from single to multi phase
7 => transfer of load to new feeders
8 => installing new sub-stations and primary feeders
9 => increasing primary voltage level
10 => Application of voltage regulators, shunt and series capacitors on the primary feeders.

The voltage control on the 1° distribution feeder thro the use of distribution transformer tap-changer, voltage regulator & shunt capacitor has been shown in the following figures.

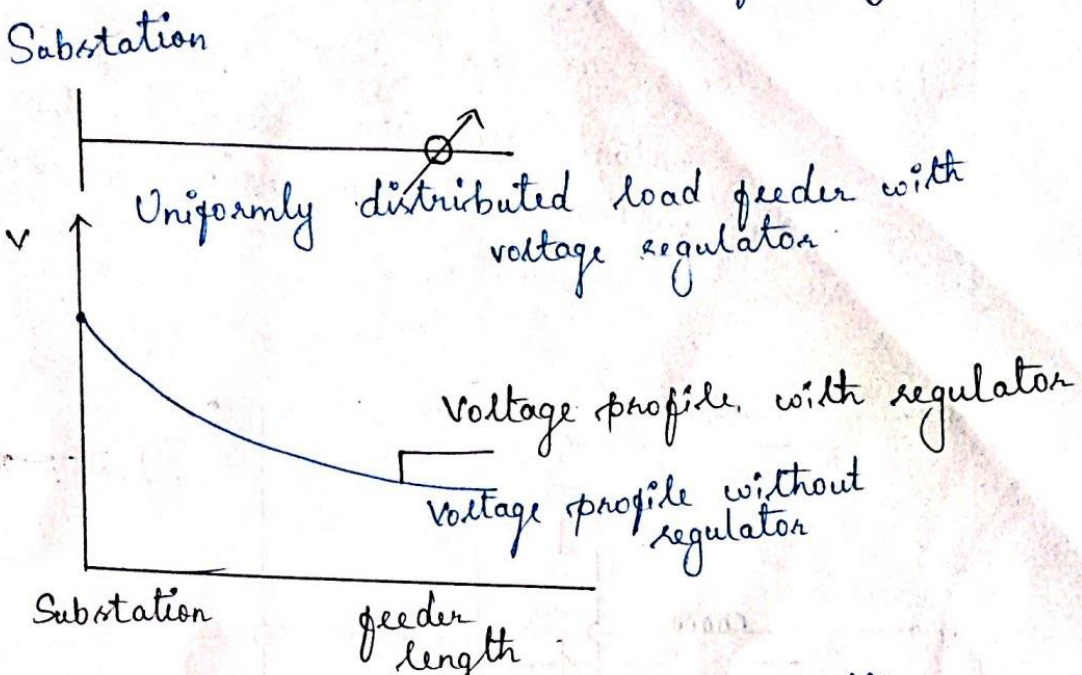
i) Single-line circuit diagram.



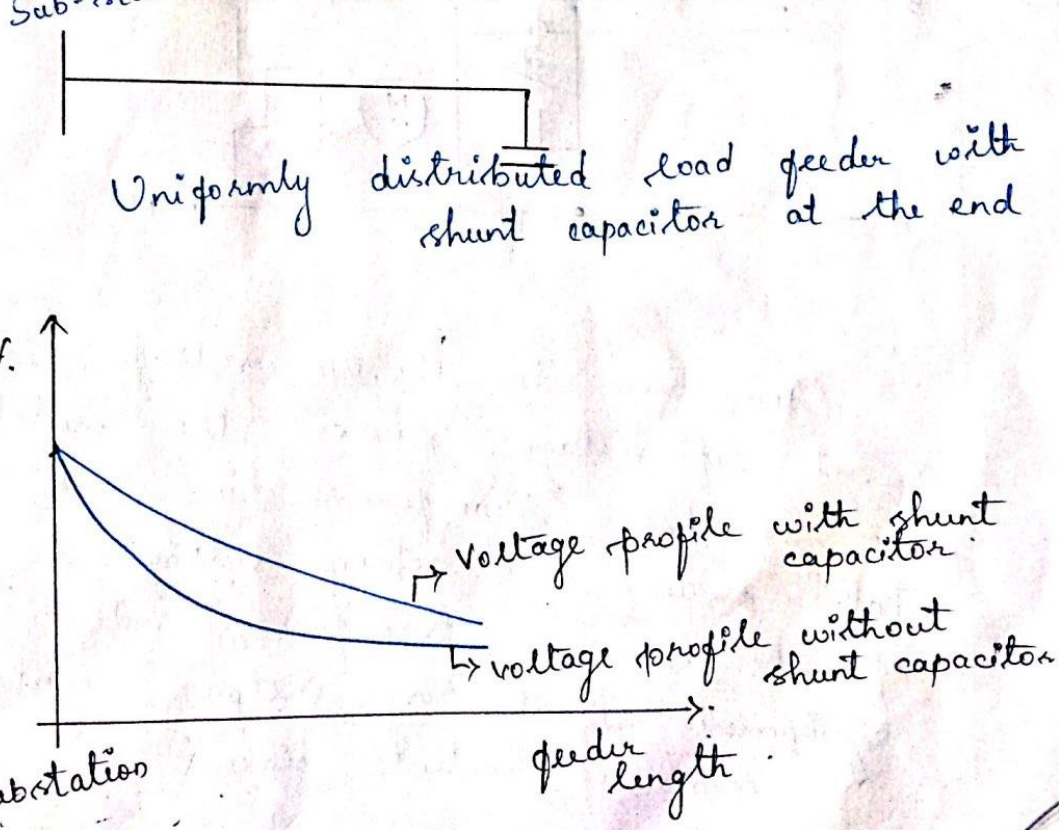
ii) Voltage drop.



iii) Voltage profile with voltage regulator.



iv) Voltage profile improvement with shunt capacitors.



6(b).

CMK

OPERATION CRITERIA AND STANDARDS.

Procedure and practices for safe and efficient operation of DS.

Power utility should prepare operational code.

CRITERIA ——→ principles of operation.

* Outage programme - notification (in advance) to consumers
* Contingency planning - if system failure happens steps to restore and maintain power supply
  Eg: mobile diesel generating set - mobile distribution transformers.
* Peak load restrictions to be notified in advance.
* Metering arrangement for energy audit - to prepare feeder wise energy balance sheet and for whole sub-station.
* Electronic meters should be adapted.

Eg for month-wise energy balance sheet.

11 KV feeder.

→ energy received at each distribution sub-station 66/11 KV.
→ energy consumption at the sub station.
→ energy sent out from each feeder.
→ energy billed for each feeder.
→ Total KWh loss "
→ Technical loss "
→ Non-technical loss.
→ Unmetered energy.

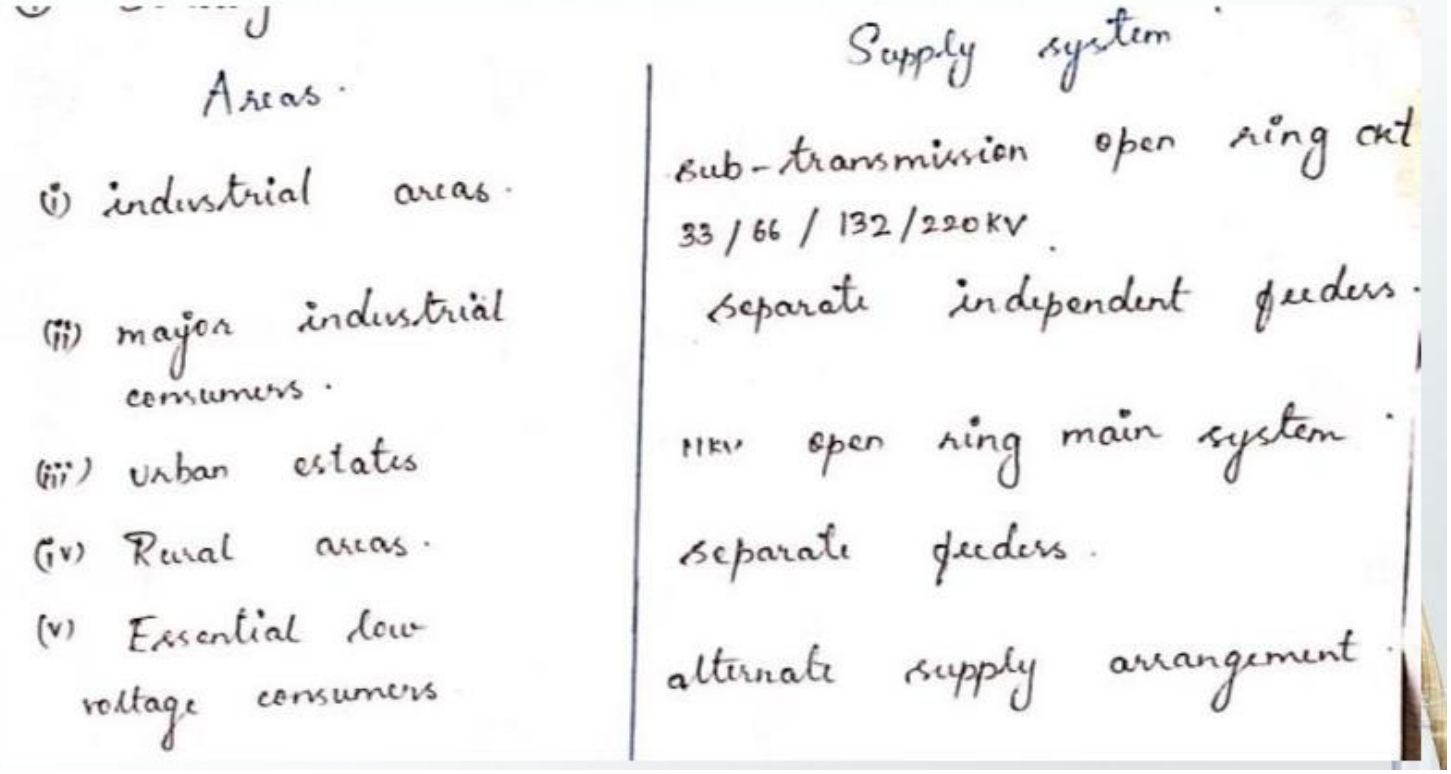
7(a).

2. Planning criteria and standards

+ Criteria & standards ➡ set of requirements
  ⬇ ⬇
+ Rules specifications
+ Criteria and standards gives direction of master plan
+ Depends on vision mission and values

Planning Criteria

1. Perspective **plan** for next 15 years to meet load growth and forecast load. **Review** the plan annually.
2. **Project report** for system strengthening works (both long term and short term): poor performance of Feeder , addition of new technology, loss minimization plan.
3. **DSM** project reports.
4. **Security**



5. Standards for Voltage level

Connected load. (load demand)	Voltage supply.
i) 10KW	240V, 1ϕ two wire.
ii) 10KW – 50KW	415/240V, 3ϕ four wire.
iii) 50KW – 5MW	11 KV
iv) 5MW – 30MW	33 or 66KV
v) 30MW – 50MW	132 KV
vi) >50MW	220KV

6. Power utility would create and use load research facilities to identify **customer load profiles**
7. **Number** of **feeders** on distribution station and **length** of feeder
8. **Loss minimization :** improved metering , LT line length should not be more than 0.8 km , harmonic distortion < 5%.
9. Load growth of minimum 10 yrs have to be taken for new planning
10. Fixed LT capacitors on transformers


Planning standards
+ Rules laid by IS, IER, REC, IEC, ISO and electricity act 2003.
+ Types of standards
+ Standard cost for material and labour
+ System voltage
+ Load growth of at least 10 years.
+ Shunt capacitor for improvement of PF
+ Fixed LT capacitors on distribution transformers.

7(b).

GPS

+ Global positioning system: Earth Orbiting satellites provide precise information on time and position

GPS

+ Why GPS is used in distribution network??
+ To **locate** tap off points, transformers and other facilities of power distribution networks
+ Can be used to capture network data for **11kV and greater than that**
+ **Pole to pole** distance is fixed
+ Survey of India Sheets