1016

Code : 20EE11T

Register Number | | | | | | | | | | |

I Semester Diploma Examination, December-2023

BASICS OF ELECTRICAL POWER SYSTEM

Time : 3 Hours] **[Max. Marks : 100**

Instructions : (i) Answer **one** full question from each section.
(ii) One full question carries **20** marks.

SECTION – I

1. (a) List any five conventional sources of energy. **5**
   (b) Draw the schematic diagram of Hydro Power Plant and label the parts. **7**
   (c) Classify Hydro Power Plants based on available head of Water and Plant capacity. **8**

2. (a) Explain the importance of electrical power generation. **5**
   (b) List the advantages and disadvantages of Thermal Power Plant. **7**
   (c) Draw the labelled schematic diagram of gas turbine plant and briefly explain. **8**

SECTION – II

3. (a) List any five advantages of Diesel Power Plant. **5**
   (b) Draw the schematic diagram of Nuclear Power Plant and label the parts. **10**
   (c) Compare Nuclear Power Plant with Thermal Power Plant. **5**

4. (a) List the factors to be considered for site selection for Wind Power Plant. **5**
   (b) Explain the construction of Solar Photovoltaic Panel with block diagram. **10**
   (c) Classification of Solar Photovoltaic Systems. **5**

SECTION – III

5. (a) Mention any five applications of Solar Cell. 5
   (b) Comparison any five horizontal axis and vertical axis wind turbine generator. 5
   (c) Explain the working of stand alone photovoltaic system with block diagram. 10

6. (a) Mention the sources of Biomass. 5
   (b) Draw the line diagram of biomass power plant. 5
   (c) What is fuel cell ? Classify and mention the application of fuel cells. 10

SECTION – IV

7. (a) Explain with block diagram municipal solid waste to energy incineration plant. 8
   (b) Define the following : 8
   (i) Connected Load
   (ii) Firm Power
   (iii) Cold Reserve
   (iv) Hot Reserve
   (c) Explain load curve with graph. 4

8. (a) The maximum demand on power station is 100 MW. If the annual load factor is 40%, calculate the total energy generated in a year. 6
   (b) A generating station has a connected load of 40 MW and a maximum demand of 20 MW. The units generated being 61.5×10^6 kwhr/annum. Calculate (i) Demand factor (ii) Load factor. 6
   (c) Draw the single line diagram of AC transmission and distribution and label the parts. 8

SECTION – V

9. (a) Draw the block diagram of HVDC transmission and explain the function of each block. 10
   (b) Explain classification of transmission lines based on length. 6
   (c) List any four functions of substation. 4

10. (a) Define electrical grid. Differentiate state grid and national grid. 6
   (b) Define brown out and black out. 4
   (c) Mention any four distribution companies in Karnataka. Distinguish between feeder, distributer and service mains. 2 + 8

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20EE11T – BASICS OF ELECTRICAL POWER SYSTEM

Scheme of Valuation

Question No.	Particulars & Splitting of Marks	Marks Awarded
	SECTION-I	
1.(a)	Any five conventional sources[5x1]	**5**
(b)	Diagram[5]+Label[2]	**7**
(c)	Classification on head of water[3x1]+Classification on plant capacity [5x1]	**8**
2.(a)	Any Five importance[5x1]	**5**
(b)	Any four advantages[4x1]+Any three disadvantages[3x1]	**7**
(c)	Schematic diagram[5]+ Explanation [3]	**8**
	SECTION-II	
3.(a)	Any five advantages[5x1]	**5**
(b)	Schematic diagram[7]+ Label [3]	**10**
(c)	Any five Comparison[5x1]	**5**
4.(a)	Any five factors[5x1]	**5**
(b)	Block diagram[6]+ Explanation [4]	**10**
(c)	Any five classifications[5x1]	**5**
	SECTION-III	
5.(a)	Any Five applications[5x1]	**5**
(b)	Any five Comparison[5x1]	**5**
(c)	Block diagram[6]+ Explanation [4]	**10**
6.(a)	Any five sources of biomass[5x1]	**5**
(b)	Line diagram[5]	**5**
(c)	Definition [2]+ Any four classifications [4]+ Any Four applications [4]	**10**
	SECTION-IV	
7.(a)	Block diagram[5]+ Explanation [3]	**8**
(b)	Definition[4x2]	**8**
(c)	Graph[2]+ Explanation [2]	**4**
8.(a)	Data listing[1]+ Formula[2]+Calculation[3]	**6**
(b)	Data listing[1]+ Formula for demand factor & load factor[1+1]+Calculation for demand factor[1]+ Calculation for load factor[2]	**6**
(c)	Single line diagram[5]+Label[3]	**8**
	SECTION-V	
9.(a)	Block diagram[5]+ Explanation [5]	**10**
(b)	Explain Any three classifications[3x2]	**6**
(c)	Any four functions[4x1]	**4**
10.(a)	Definition[2]+ Differentiate[2+2]	**6**
(b)	Definition[2x2]	**4**
(c)	Any four distribution companies[$4x\frac{1}{2}$]+ feeders[3]+Distributer[3] + service mains[2]	**2+8**

20EE11T Model Answers for December-2023

SECTION-I

1. (a) List any five conventional sources of Electrical Energy. **5**

The different conventional sources of energy available in nature are:

i. Hydro power or Water power

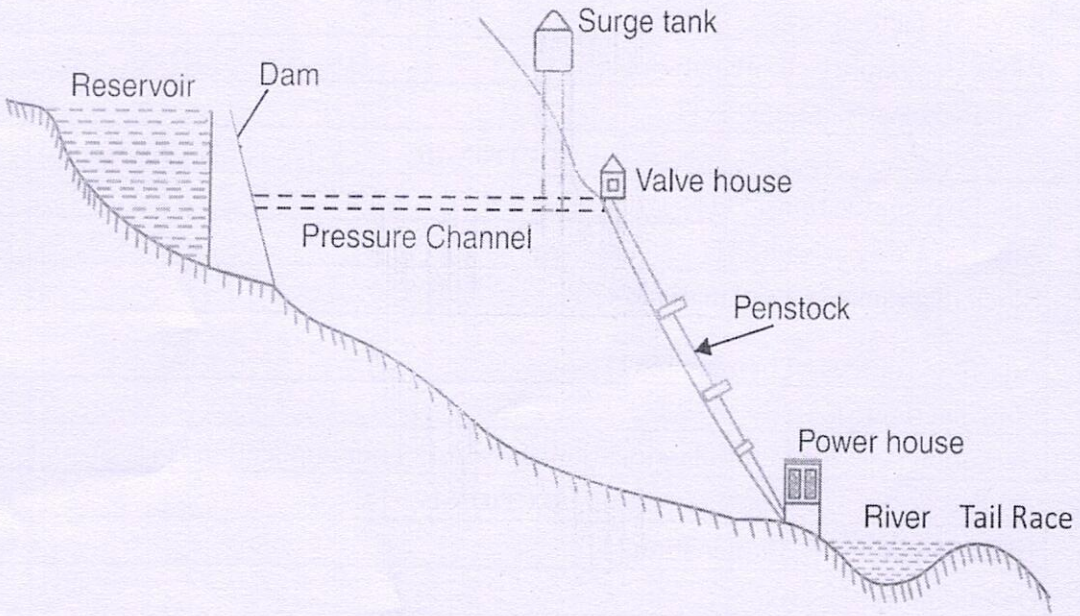
ii. Thermal power or Solid fuel (coal)

iii. Diesel power or Liquid fuel (diesel, petrol)

iv. Nuclear power

v. Gaseous fuel (natural gas)

(b) Draw the schematic diagram of Hydro Power Plant and label the parts. **7**



(c) Classify, Hydro Power Plants based on available head of water and plant capacity. **8**

1. Based on head of water:

i.Low head power plant

ii.Medium head power plant

iii.High head power plant

2. Based on plant capacity

i.Micro hydro plant

ii.Mini hydro plant

iii.Small hydro plant

iv.Medium hydro plant

v.Large hydro plant

2. (a) Explain the importance of electrical power generation 5

The electrical power generation is important due to following reasons:

i.Convenient form: Electrical energy is a very convenient form of energy. It can be easily converted into other forms of energy like heat, light, Mechanical energy, chemical energy, etc.

ii.Easy control: The electrically operated machines have simple and convenient starting, Control and operation.

iii.Greater flexibility: Electrical energy offers greater flexibility and it can be easily transported From one place to another with the help of conductors.

iv.Cheap: Electrical energy is much cheaper than other forms of energy. Thus it is economical To use electrical energy for domestic, commercial and industrial purposes.

v.Cleanliness: Electrical energy is not associated with smoke, fumes or poisonous gases. Hence it is non-polluting.

vi.High transmission efficiency: Electrical energy can be transmitted conveniently and efficiently From the centers of generation to the consumers with the help of transmission lines.

(b) List the advantages and disadvantages of Thermal Power Plant 7

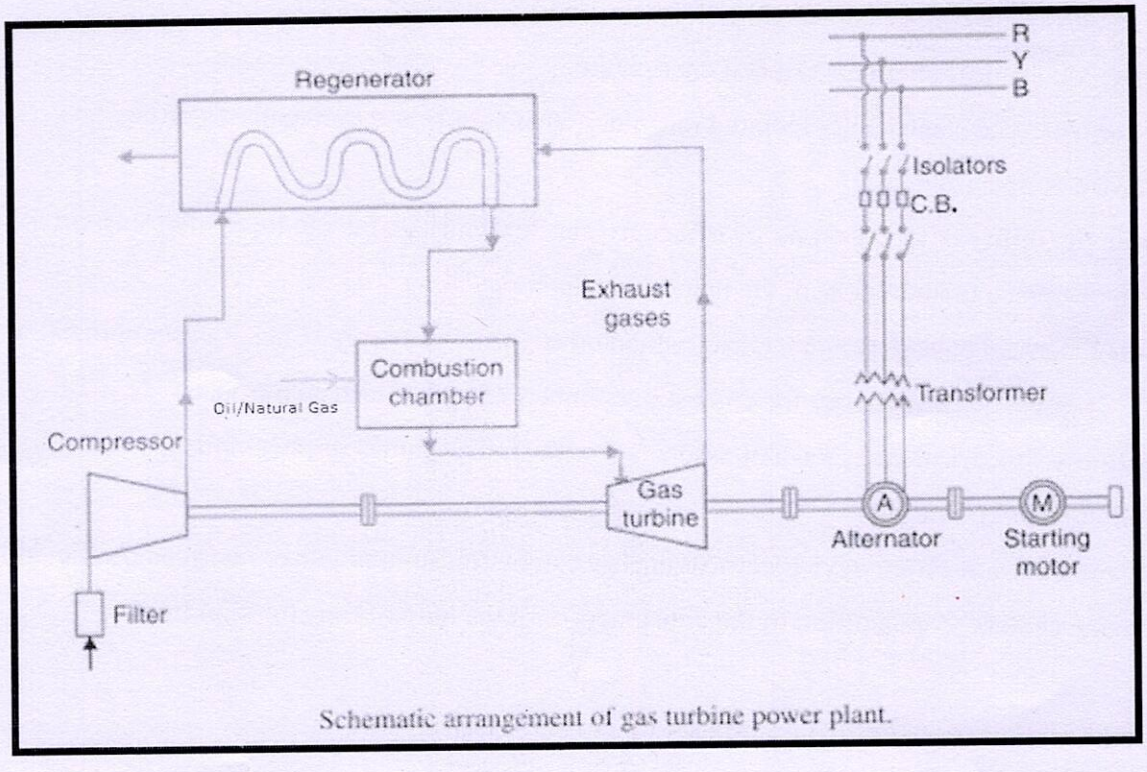
Advantages of Thermal power plant:

1. The cost of the fuel is cheap.
2. The initial cost is less when compared to hydel or nuclear power station.
3. It requires less space when compared to hydroelectric plant.
4. Cost of power generation is less than that of diesel power station.
5. Large amount of power can be generated by thermal power station.
6. It can be located near the load centers which reduces transmission cost and losses.

Disadvantages of Thermal power plant:

1. Pollutes the atmosphere due to production of ash, dust, fumes and smoke.
2. Running cost is high when compared to hydroelectric power station.
3. Maintenance cost is more.
4. The power plant cannot be started instantly.
5. Standby losses in the boiler are more.
6. Losses are more and hence efficiency is less.

(c) Draw the labeled schematic diagram of gas turbine plant and briefly explain. **8**



Schematic arrangement of gas turbine power plant.

Compressor:

- Air at atmospheric pressure is drawn and compressed in a compressor.
- Filter removes the dust from the air.
- The high-pressure air from the compressor is then fed to the regenerator.

Regenerator:

- Regenerator is used for preheating the compressed air.
- The hot exhaust gas from the gas turbine is passed over these tubes to pre-heat the compressed air.
- This pre-heated compressed air is fed to the combustion chamber.

Combustion chamber:

- Oil or natural gas is also injected into the combustion chamber at high pressure.
- The oil mixes with compressed air and undergoes combustion.
- The hot high-pressure gas produced in the combustion chamber is then fed to the gas turbine.

Gas turbine:

- Gases at high pressure and temperature from the combustion chamber are passed into the gas turbine and converts to mechanical energy.

Alternator:

- Alternator coupled to the gas turbine converts the mechanical energy of turbine into electrical energy.

Starting motor:

- Compressor, turbine and alternator are all mounted on the same shaft.
- Before starting the turbine, the compressor has to be started. For this purpose, a starting motor is used.
  The starting motor is mounted on the same shaft and is energized by the batteries to start the compressor.

SECTION-II

3. (a) List any five advantages of Diesel Power Plant. 5

(1) Simple in design and layout

(2) It occupies Less Space

(3) It can be located at any place

(4) It can be started quickly

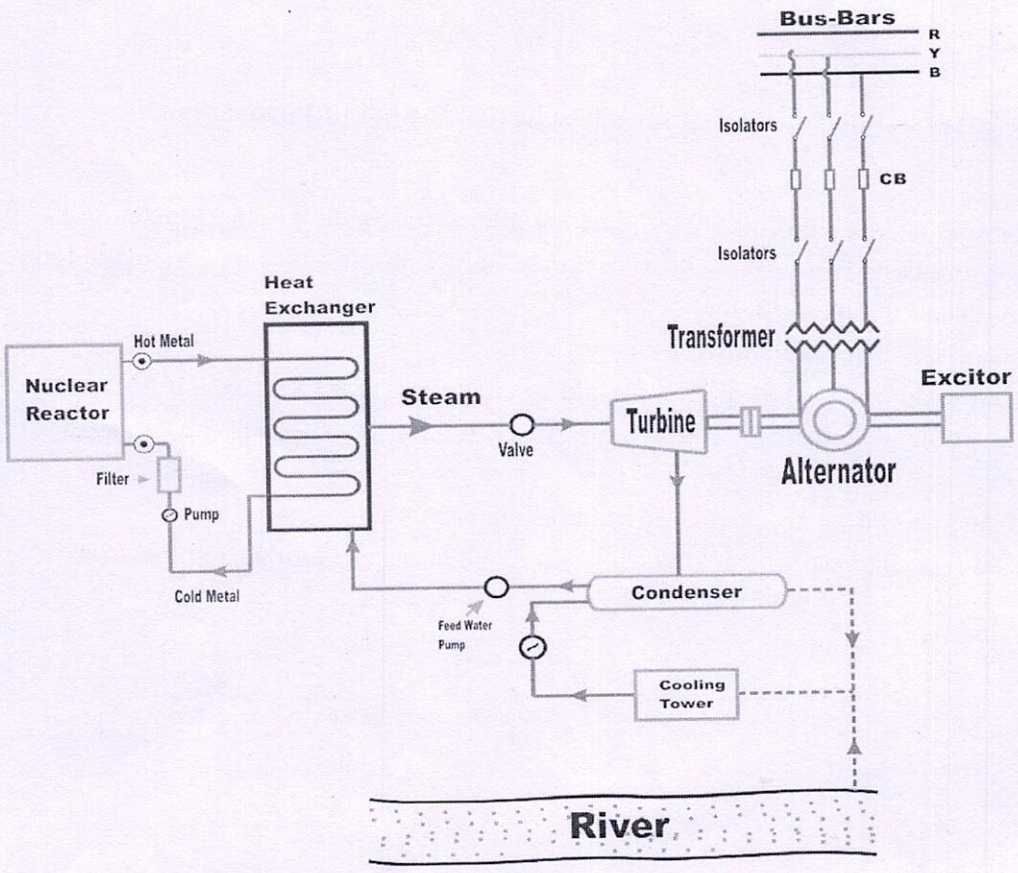
(5) It can pick up load in short time

(6) It requires less water for cooling

(7) Overall cost is much less than steam power station of the same capacity.

(8) Thermal efficiency is higher than that of steam power plant

(b) Draw the schematic diagram of Nuclear Power Plant and label the parts. 10



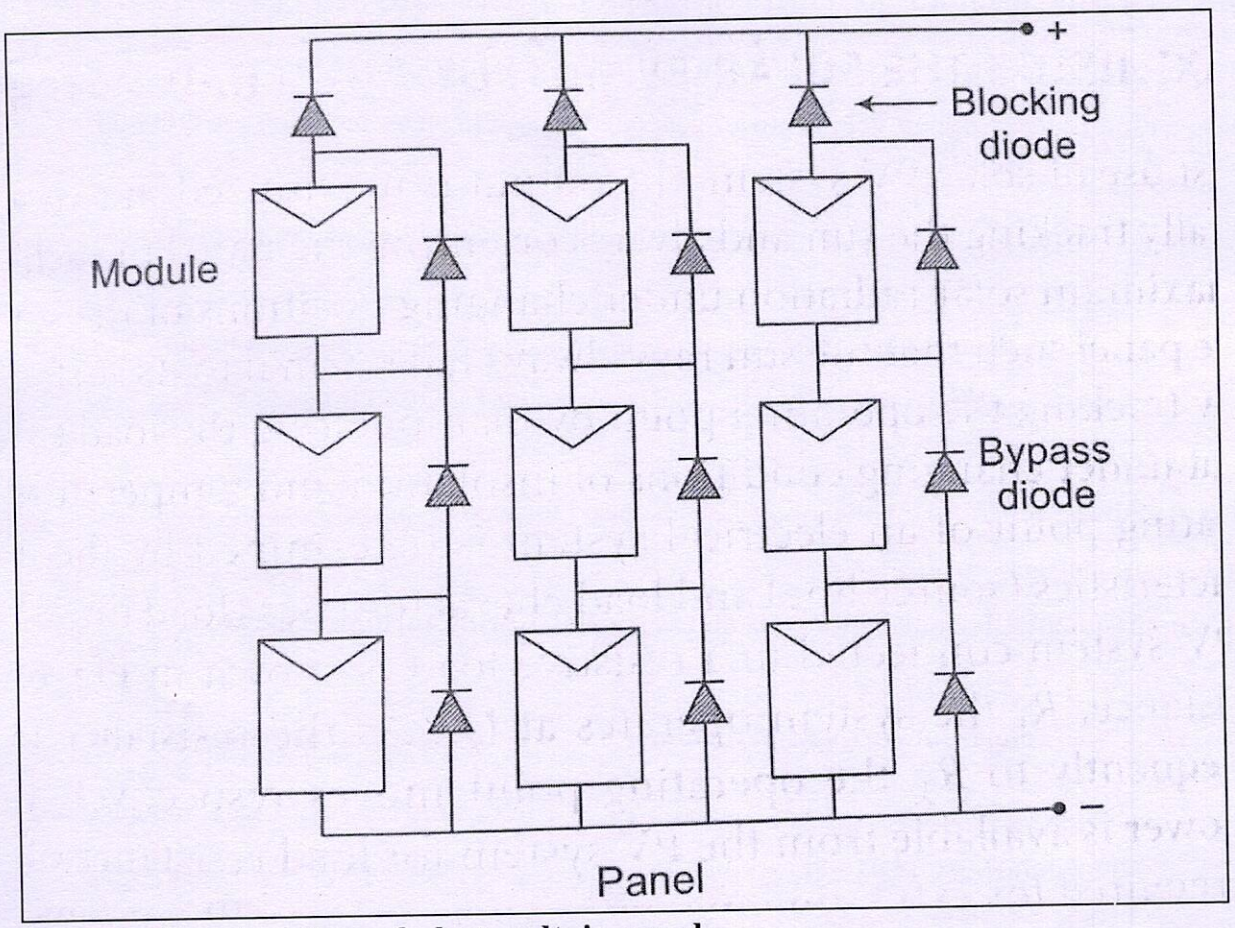
(c) Compare Nuclear Power Plant with Thermal Power Plant. 5

Sl. No.	Nuclear power plant	Thermal power plant
1	Heat released due to nuclear fission of Uranium (U^{235}) is used for steam generation.	Heat released due to combustion of coal is used for steam generation.
2	Amount of fuel required is very less.	Large amount of fuel is required.
3	Transportation cost of fuel is less.	High transportation cost of fuel.
4	Space required for the nuclear power plant is less.	Space required is more when compared to nuclear power plant.
5	Low running cost and high capital cost.	High running cost and relatively low capital cost.
6	It produces radioactive waste and hence disposal of waste is very difficult.	Does not produce radioactive waste and hence waste disposal is not very difficult.
7	It uses wet steam of relatively low temperature and pressure.	It uses dry steam and its temperature and pressure is high when compared to nuclear power plant.

4. (a) List the factors to be considered for site selection for Wind Power Plant. 5

a) The site selected for wind power plant should have an average wind speed of 20- 30km/h.
b) It is desirable to install wind power plant at higher altitudes because the wind tends to have higher velocities at higher altitudes.
c) The land cost should be low.
d) The ground condition of the site should be such that strong foundation for tower is possible.
e) Icing problem, salt spray or blowing dust should not be present at the site as they affect the turbine blades.
f) The land should be accessible by road or rail.
g) The site should be near the load centre to reduce transmission cost and losses.

(b) Explain the construction of solar Photovoltaic panel with block diagram. **10**



Construction of photovoltaic panel:

- A single solar module can produce only limited power.
- So, modules are connected in series - parallel combination to increase the voltages or

  Current in the working system. They are known as photovoltaic panels.
- Figure shows the series-parallel connection of modules in a panel.
- In parallel connection, blocking diodes are connected in series with each string of modules.

  If any string fails, the blocking diode prevents the absorption of power output of the remaining

  Strings from the failed string.
- Bypass diodes are installed across each module. They are used to bypass the failed module.

(c) Classification of Solar Photovoltaic Systems. **5**

Solar **Photovoltaic** systems are broadly classified as:

1. Central Power Station System
2. Distributed System
   a) Stand-alone solar photovoltaic system
   b) Grid interactive system
   c) Hybrid system

SECTION-III

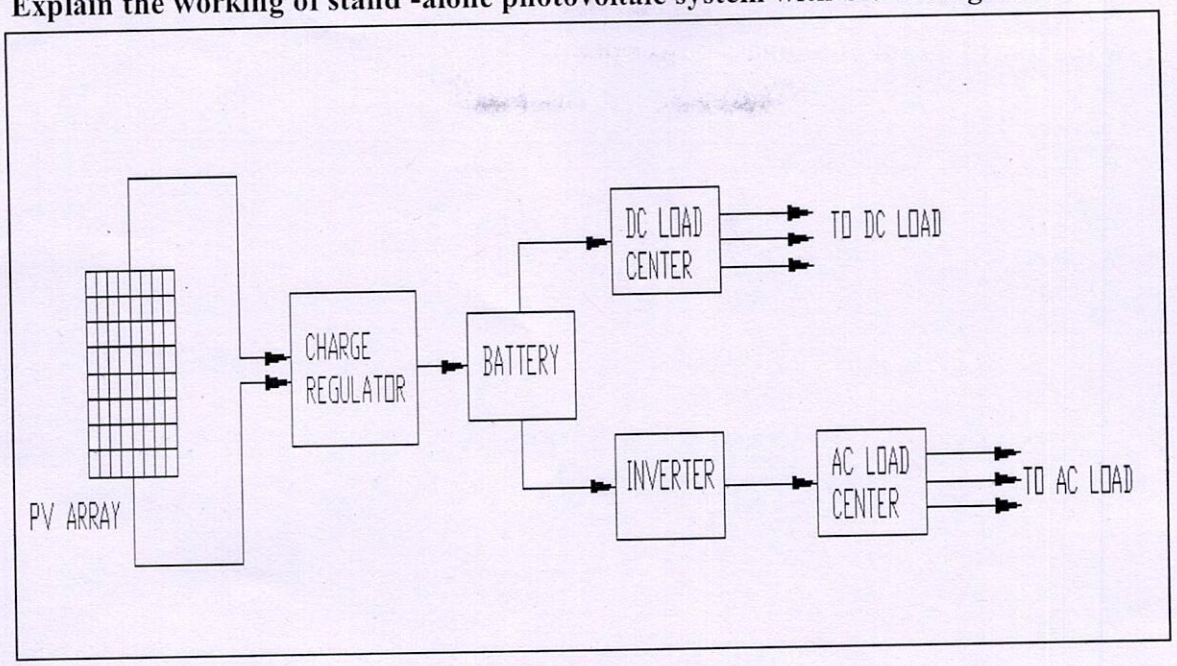
5. (a) Mention any five applications of Solar Cell. 5

1. **Grid interactive photo voltaic power generation:** In grid interactive solar photovoltaic system, the power generated by PV system is fed to the central power grid.
2. **Water Pumping:** The photovoltaic power generated is used in water pumping for drinking and irrigation.
3. **Lighting:** The photovoltaic power generated is used for street lighting and in portable solar lantern.
4. **Medical Refrigeration:** Many life saving drugs and vaccines require refrigerators for storage and transportation. Solar photovoltaic refrigerators are used for such applications.
5. **Village Power:** Solar photovoltaic power is also used for feeding power to small, isolated and remote villages.

(b) Comparison any five horizontal axis and vertical axis wind turbine generator. 5

Sl No	Horizontal axis wind turbine	Vertical axis wind turbine
1	In this turbine, the shaft is mounted horizontally parallel to the ground.	In this turbine, the shaft is mounted on a vertical axis perpendicular to the Ground.
2	It uses tower for support.	It uses guy wires for support.
3	Gear box and generator are Mounted above the ground on a tower.	Gearbox and generator are mounted at ground level.
4	Installation and maintenance are Difficult as the equipments are at height.	Easy installation and maintenance as all the equipments are at ground level.
5	Yaw mechanism is required to Align the blades to face the wind.	Yaw mechanism is not needed as the Rotor rotates for any wind direction.
6	Turbine rotor is at higher elevation,so higher wind speed and higher Efficiency.	Turbine rotor is almost at groundlevel so lower wind speed and lower Efficiency.
7	It takes little ground space.	It takes larger ground space.
8	Energy output is more.	Energy output is less.

(c) Explain the working of stand -alone photovoltaic system with block diagram. **10**

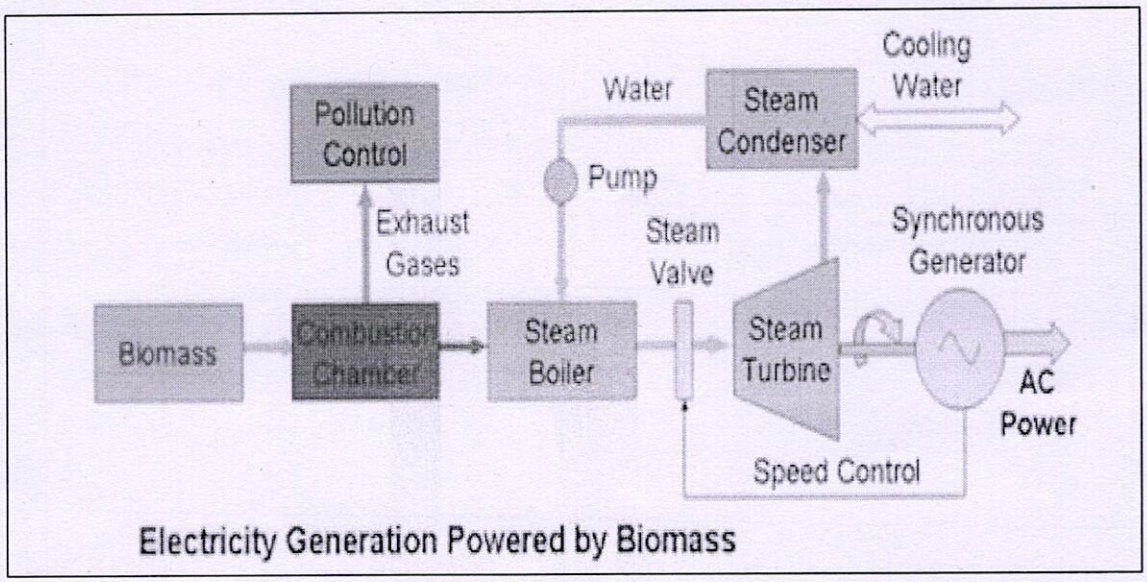


- Fig shows the block diagram of standalone solar photovoltaic system.
- It consists of photo voltaic array, charge regulator, battery, inverter, DC load centre and AC load centre.
- The DC output of the PV array is connected to the battery through the charge regulator unit.
- The charge regulator consists of a blocking diode in series with the photovoltaic array. It prevents the battery from being discharged through the PV array at night when there is no sunshine.
- The blocking diode also prevents overcharging and discharging of battery and also protects the battery from short circuits.
- Battery output can be directly connected to the DC loads.
- For AC loads, the battery output is first connected to an inverter which converts DC to AC and then it is connected to AC load centre.

6. (a) Mention the sources of Biomass. **5**

1. **Forests:** Forest is a source for fuel wood, charcoal and producer gas.
2. **Agricultural Residues:** Crop residues such as rice husk, coconut shell, groundnut shell, sugarcane, and bagasse can be gasified to get producer gas.
3. **Energy Crops:** Crops like sugar cane, sugar beet, starch plants, oil producing plants form the raw material for biofuel.
4. **Aquatic Plants:** Water plants like hyacinth, seaweed and algae provide raw material for biogas.
5. **Urban Waste:** There are two types of urban waste a) Municipal solid waste b) Sewage. Energy from MSW is obtained from combustion. Sewage can be used to produce biogas.

(b) Draw the line diagram of biomass power plant. **5**



(c) What is fuel cell? Classify and mention the application of fuel cell. **10**

Fuel Cell: Fuel cell is an electrochemical energy conversion device that converts chemical Energy of the fuel into DC electrical energy.

Classification of fuel cells: Based on the type of electrolyte used, fuel cells are classified as:

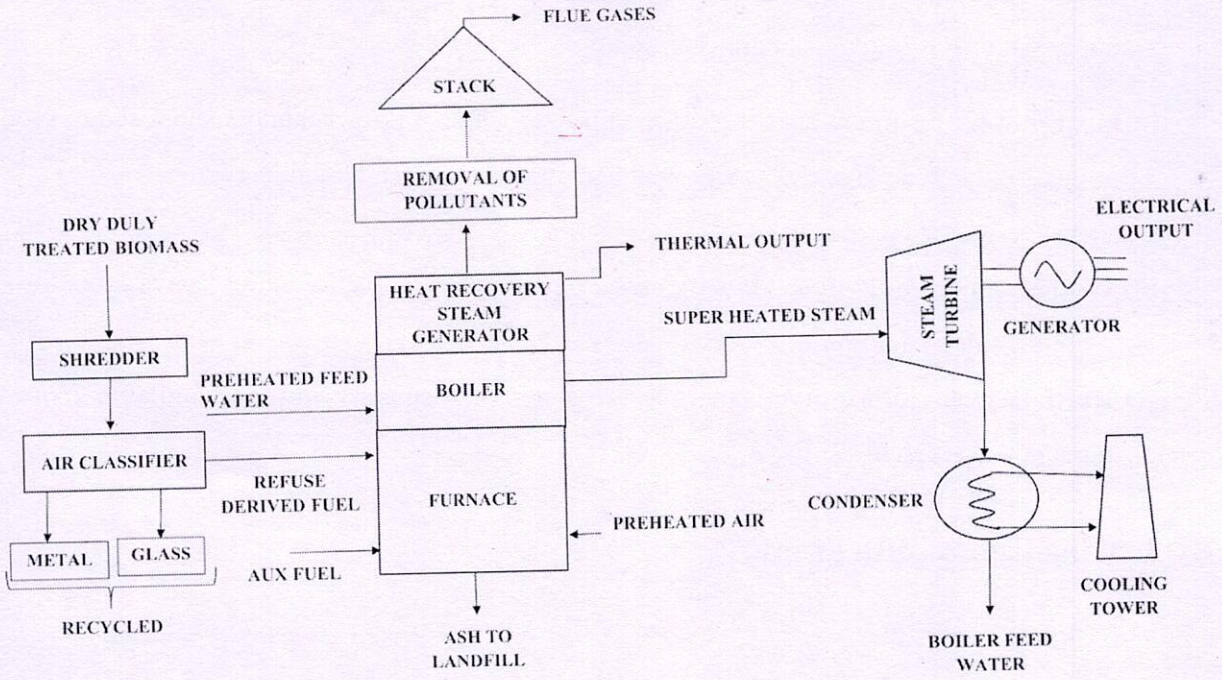
a) Phosphoric Acid Fuel Cell (PAFC)
b) Alkaline Fuel Cell (AFC)
c) Polymer Electrolytic Membrane Fuel Cell (PEMFC)
d) Molten Carbonate Fuel Cell (MCFC)
e) Solid Oxide Fuel Cell (SOFC)

Applications of fuel cells:

a) Used in central power generation.
b) Used as residential power source of 5 to 10 KW.
c) Used as emergency power supplies in hospitals.
d) Used as power source in submarines and space craft's.
e) Used to power electric vehicles for road and rail transport.
f) Used as power source in communication systems.

SECTION-IV

7. (a) Explain with block diagram municipal solid waste to energy incineration plant. **8**



- Figure shows the block diagram of MSW to energy incineration plant.
- The dry biomass is cut (shredded) into small pieces of 2.5 cm in diameter.
- The air stream separates the lighter refuse derived fuel (RDF) from the heavier metal and glass pieces. These glass and metal pieces can be recycled and reused.
- The RDF thus obtained undergoes combustion in presence of preheated air in a furnace at about 10000C.
- The combustion process may be assisted by using auxiliary fuel if needed.
- The hot flue gases from the furnace are used to produce steam in the boiler.
- The superheated steam thus obtained from the boiler is used to run steam turbine coupled with an alternator to generate electricity.
- The exhaust steam from the steam turbine is condensed using condenser and cooling tower and is fed back to the boiler as feed water.
- The heat recovery steam generator (HRSG) extracts maximum possible heat from the flue gases to form thermal output. This may be utilized for preheating air and feed water to the boiler.
- The flue gases are then discharged in to atmosphere through the stack after removing pollutants such as particulate matter and oxides of nitrogen and sulphur.
- The ash is removed and disposed in the landfills.

(b) Define the following: (i) Connected load (ii) Firm power (iii) Cold Reserve (iv) Hot Reserve **8**

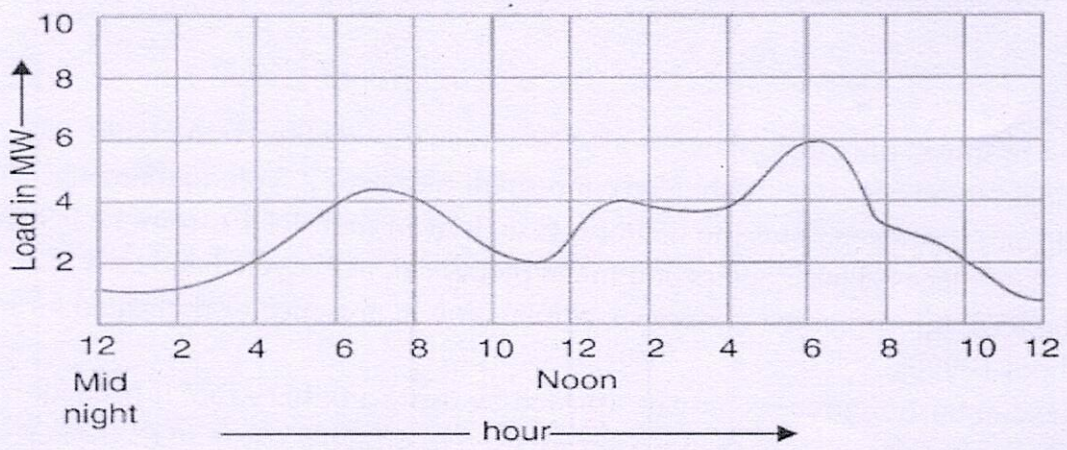
(i) Connected load: The sum of continuous rating of all the equipment connected to electrical supply system is known as connected load.

(ii) Firm power: Firm power is the value of power which a power plant is supposed to produce throughout the year. It is the power which should always be available even under emergency conditions.

(iii) Cold Reserve: Cold Reserve is that reserve generating capacity which is available for service but is not in operation.

(iv) Hot Reserve: Hot Reserve is that reserve generating capacity which is available in operation but is not in service.

(c) Explain load curve with graph. **4**



Load curve: The curve showing the variation of load on the power station with respect to time is known as load curve.

- The daily load curve shows the variation of load on the power station during different hours of the day.
- The area under the daily load curve gives the number of **units generated in the day.**
  - Unit generated/day= Area (in kWh) under daily load curve.
- The highest point on the daily load curve represents the **maximum demand** on the station on that day.

8. (a) The maximum demand on power station is 100 MW, if the annual load factor is 40%, Calculate the total energy generated in a year. 6

Given Data:

Maximum Demand = 100MW = $100 * 10^3$ kW

Annual Load Factor = 40% = 40/100 = 0.4

Total no. of days in year = 365

Total no. of hours in year = 365 * 24 hours of the day = 8760

To Find:

Total energy generated in a year.

Formula used:

Energy generated in a year

= Units generated per annum

= Maximum demand (in kW) × Load factor * Number of hours in a year

Solution:

Energy generated in a year = Maximum demand (in kW) ×Load factor ×Number of hours in a year

Energy generated in a year = $(100 \times 10^3) \times 0.4 \times 8760 = \mathbf{3504 \times 10^5}$ **kWh.**

(b) A generating station has a connected load of 40MW and a maximum demand of 20 MW. The units generated being $61{\cdot}5 \times 10^6$ kWh/ annum. Calculate :(i) the demand factor and (ii) load factor. 6

Given Data:

Connected load = 40MW

Maximum demand = 20MW

Units generated per annum= $61.5*10^6$ kWh/annum

To Find: (i) the demand factor (ii) the load factor.

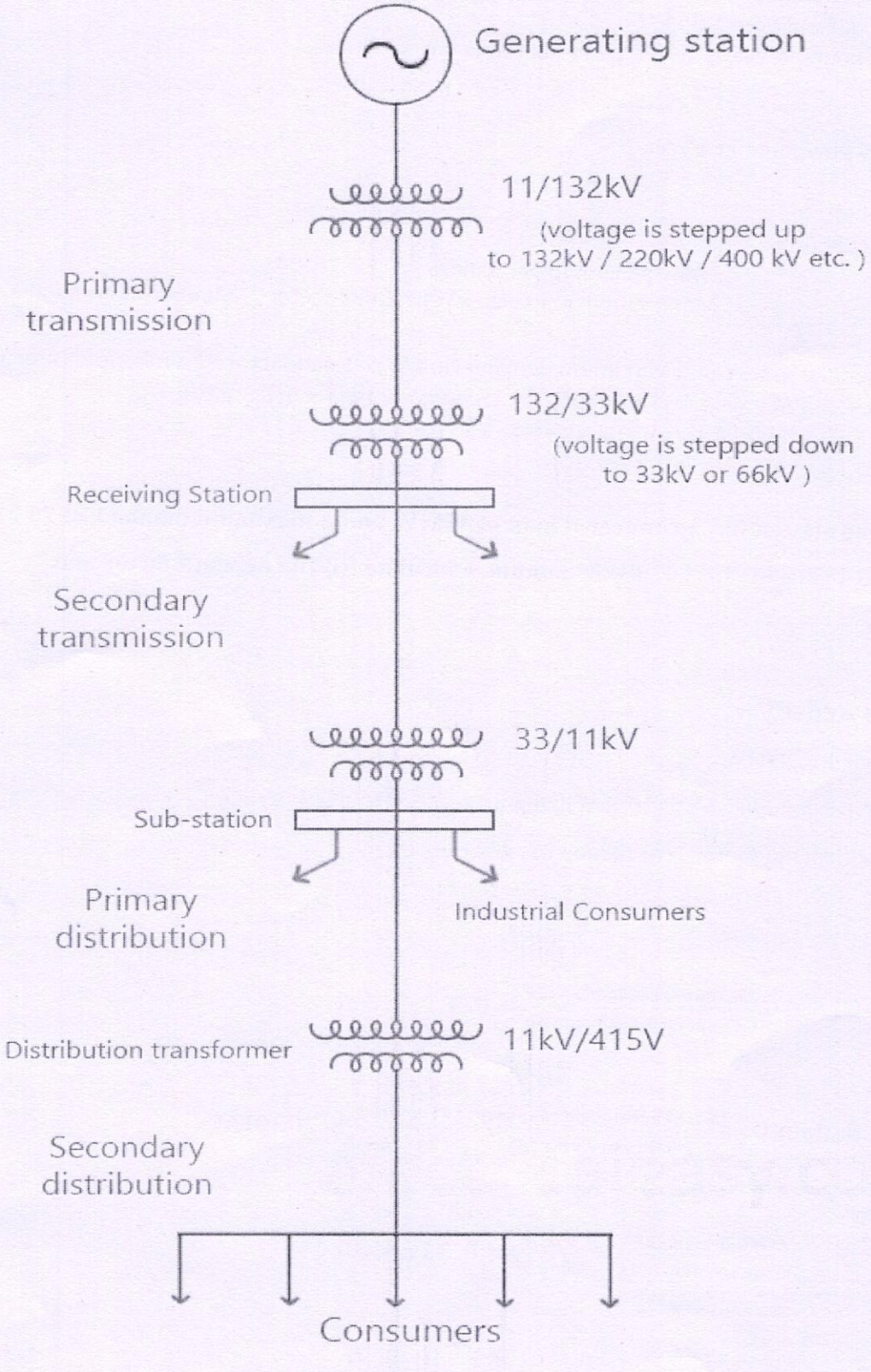
Solution:

(i) Demand factor $= \frac{\text{Maximum Demand}}{\text{Connected Load}} = \frac{20}{40} = \mathbf{0.5}$

Average demand$= \frac{\text{units generated per annum}}{\text{hours in a year}} = \frac{61{\cdot}5 \times 10^6}{24 \times 365} = \mathbf{7020KW}$

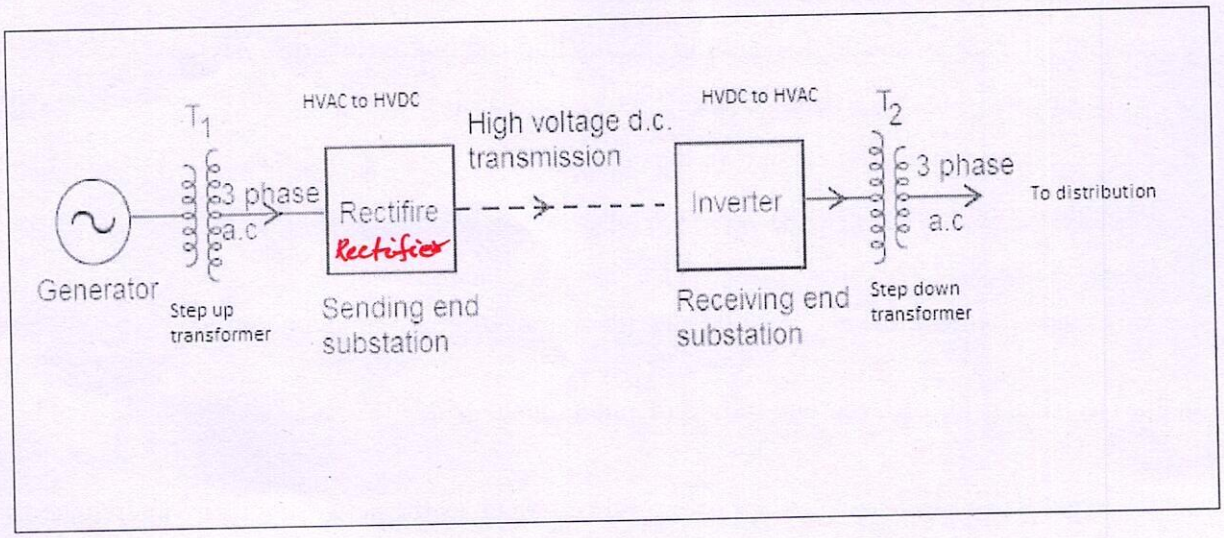
(ii) Load factor$= \frac{\text{Average demand}}{\text{Maximum demanad}} = \frac{7020}{20 \times 10^3} = \mathbf{0.351 = 35.1\%}$

(c) **Draw the single line diagram of AC transmission and distribution and label the parts.** **8**



SECTION-IV

9. (a) Draw the block diagram of HVDC transmission and explain the function of each block **10**



The following are the main components of HVDC transmission system:

- **Generator:** Three phase AC electrical power is generated using generator.
- **Step up transformer:** At the sending end, the three-phase generated AC voltageis

  Stepped up to a suitable level using step up transformer.
- **Rectifier:** This high voltage AC is rectified into high voltage DC using rectifier.
- **HVDC long distance transmission line:** The high voltage DC is then transmitted to

  Receiving using HVDC long distance transmission line.
- **Inverter:** At the receiving end, high voltage DC is converted into three phase

  high voltage AC using inverter.
- **Step down transformer:** The three-phase high voltage AC is stepped down to low voltage using

  step down transformer. This reduced AC voltage is sent for distribution.

(b) Explain the classification of transmission lines based on length. **6**

Based on the length of transmission line:

1) **Short transmission line** - When the length of an overhead transmission line isup to about 80km and the line voltage is below 20 kV, it is considered as shorttransmission line.
2) **Medium transmission line** - When the length of an overhead transmission line is between 80-250 km and the line voltage is between 20 kV to 100 kV, it is considered as medium transmission line.
3) **Long transmission line** - When the length of an overhead transmission line is more than 250 km and the line voltage is above 100 kV, it is considered as long transmission line.

(c) List any four functions of substation. **4**

1. It change voltage from one level to another.
2. It switch transmission and distribution circuits into and out of the grid system.
3. It measures various parameters of electric supply system.
4. It connect communication signals to the circuits.
5. It eliminate lightning and other electrical surges from the system.
6. It connect electric generation plants to the system.
7. Make inter connections between the electric systems of more than one utility.

10. (a) Define electrical grid. Differentiate state grid and national grid. **6**

Electrical grid: An Electrical grid or power grid is defined as the network which interconnects the generation, transmission and distribution unit. It supplies the electrical power from generating unit to the distribution unit.

The State Grid is the network connecting the power plants, to consumers for power distribution across the state.

The National Grid distributes electricity across the country. The national grid inter connects the state/regional grids of the nation with network of high-voltage power lines.

(b) Define brown out and black out. **4**

BROWN OUT: A brownout is an intentional or unintentional drop in voltage in an electrical power supply. The term brownout comes from the dimming of incandescent lighting when the voltage reduces.

BLACK OUT: A blackout is a total loss of electrical power to particular area. It is caused by an imbalance between power generation and consumption .Blackouts can last for just a few minutes or in the worst-case scenario stretch in to several hours, days, or even weeks.

(c) **Mention any four distribution companies in Karnataka, Distinguish between feeders, Distributer and service mains.** **2+8**

The power distribution companies in Karnataka are:

1. Bangalore Electricity Supply Company Limited (BESCOM)
2. Hubli Electricity Supply Company Limited (HESCOM)
3. Mangalore Electricity Supply Company Limited (MESCOM)
4. Gulbarga Electricity Supply Company Limited (GESCOM)
5. Chamundeshwari Electricity Supply Company Limited (CESCOM)

Distinguish between Feeder, distributor and service main

Feeders:

- Generally, no tapings are taken from the feeder, so that current in it remains the same throughout. They are high voltage carriers.
- A feeder is a conductor which connects the substation to the area where power is to be distributed.
- A feeder is a designed from the point of view of its current carrying capacity

Distributors:

- A distributor is a conductor from which tapings are taken for supply to the consumers.
- A distributor is designed from the point of view of the voltage drop in it.
- It is because a distributor supplies power to the consumers.
- It runs along the street on distribution poles.

Service mains:

- A service main is generally a small cable which connects the distributor to the consumers' terminals.
- These service mains are tapped from different points of distributors.