Zeal Education Society's

ZEAL POLYTECHNIC, PUNE.

NARHE | PUNE -41 | INDIA

SECOND YEAR (SY)

DIPLOMA IN ELECTRICAL ENGINEERING

SCHEME: I SEMESTER: III

NAME OF SUBJECT: ELECTRIC POWER GENERATION

Subject Code: 22327

MSBTE QUESTION PAPERS & MODEL ANSWERS

1. **MSBTE WINTER-18 EXAMINATION**
2. **MSBTE SUMMER-19 EXAMINATION**
3. **MSBTE WINTER-19 EXAMINATION**

22327

11819

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Classify the hydro-electric plants according to the head and load basis.

b) List the types of turbine used in hydro power plant.

c) Describe the term 'Nuclear shielding' in Nuclear Power Plant.

d) Enlist the nuclear fuels.

e) Why concentrating collectors are used in solar power plant.

f) Explain the concept of following terms.

(i) Connected load

(ii) Maximum demand

g) What is a meaning of load duration curve.

Marks

2. Attempt any THREE of the following: **12**

a) Draw a block diagram of thermal power plant.

b) With a neat diagram explain solar power tower.

c) Give the four advantages of vertical axis wind mills.

d) Compare base load plant with peak load plant. (any four)

3. Attempt any THREE of the following: **12**

a) With a neat diagram explain pelton wheel turbine.

b) Draw and explain fixed dome type biogas plant.

c) Explain Squirrel Cage Induction Generator (SCIG) and also draw a diagram.

d) Explain the choice of size and number of generator units in a power plant.

4. Attempt any THREE of the following: **12**

a) Draw the schematic arrangement for a gas power plant.

b) With a neat diagram explain medium head hydro-electric power plants.

c) With a neat diagram explain solar photovoltaic power plant.

d) Draw a layout of a thermo-chemical based power plant.

e) Define the following term -

(i) Average demand

(ii) Load factor

(iii) Plant capacity factor

(iv) Plant use factor

Marks

5. Attempt any TWO of the following: **12**

a) With a neat diagram explain pumped storage hydro power plant.

b) Draw a diagram of power tower of concentrated solar power plant.

c) Give the causes and impact and reasons of grid system fault.

6. Attempt any TWO of the following: **12**

a) Explain the function of different parts of a typical nuclear power plant with neat sketch.

b) What are the criteria for selection of site for hydro electric power plant.

c) With a neat diagram explain doubly fed induction generator (DFIG).

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Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any FIVE of the following**	**10 Marks**
a)	**Classify the hydro-electric plants according to the head and load basis.**	
Ans:	**Classification the hydro-electric plants According to availability of Head of Water:** **(1 Mark)** 1. Very high head power plant 2. High head power plant 3. Medium head power plant 4. Low head power plant **Classification the hydro-electric plants According to Load basis:** **(1 Mark)** 1. Base load power plant 2. Peak load power plant	
b)	**List the types of turbine used in hydro power plant.**	
Ans:	**Following types of turbine used in hydro power plant:** **(2 Mark)** 1.Pelton wheel 2.Francis Turbine 3.Kaplan Turbine 4.Propeller Turbine	

c)	**Describe the term 'Nuclear shielding' in Nuclear Power Plant.**
Ans:	**Explanation of 'Nuclear shielding' in Nuclear Power Plant:** **(2 Marks)** Shielding is provided to absorb alpha, beta particles and gama rays which are produced during nuclear chain reaction (fission process) The function of shielding is to protect environment, humans and animals from the harmful radioactive radiation (pollution).before they are emitted to atmosphere. Shielding is made from:- 1. Thick layer of Paper are provided to stop the alpha particals 2. Thick layer of metal or Aluminum are provided to stop the beta particles 3. Thick layer of lead or concerate wall are provided all around the reactor vessel(3-m thick concrete shield) for stopping gama rays 4. Thick layer of Water or concerate wall are provided all around the reactor vessel for stopping neutrons.
d)	**Enlist the nuclear fuels.**
Ans:	**Following nuclear fuel are used in nuclear power plant:-** **(Any Two Name of fuels expected: 1 Mark each)** 1. Natural Uranium 2. Low-enriched Uranium 3. Highly–enriched Uranium 4. Fertile Material:-U238 / Th232
e)	**Why concentrating collectors are used in solar power plant.**
Ans:	**Because of following advantages concentrating type collector are used in solar power plant: -** **(Any two points are expected: 2 Marks)** 1. Temperature: Temperature obtained is high because absorber area is less and collector/reflector area is more. 2. Heat Losses: Losses are less as absorber area is small 3. Efficiency: Efficiency is high 4. Heat insulation: Heat insulation required is less as absorber area is small. 5. Anti-freeze protection: Little or no anti-freeze protection is required to protect the absorber. 6. Used to generate steam electricity: Can be used to generate electricity with the help

of steam turbine.

7. Due to tracking better results: As tracking system is used better results are obtain than flat type collector.

f) Explain the concept of following terms : (i) Connected load (ii) Maximum demand

Ans:

1. Connected Load: **(1 Mark)**

It is the sum of load of all equipment's connected to supply system which are in use or not in use of each consumer. **OR**

The sum of connected load of all consumers is the connected to the power station or power system.

2. Maximum Demand: **(1 Mark)**

It is the maximum load which a consumer uses at a particular time period out of his total connected load.

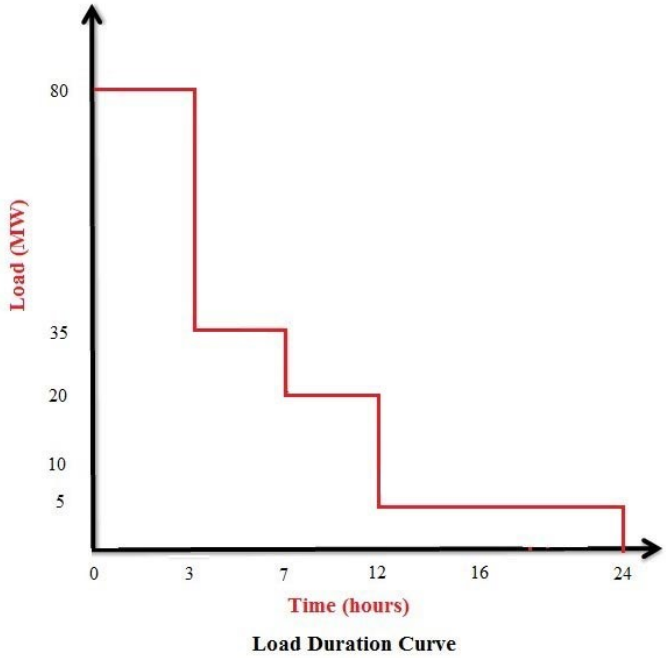
g) What is a meaning of load duration curve.

Ans:

Load duration curve: **(2 Mark)**

It is drawn from load curve. It is graph of load (MW/KW) arranged in descending order of magnitude with respect to time.

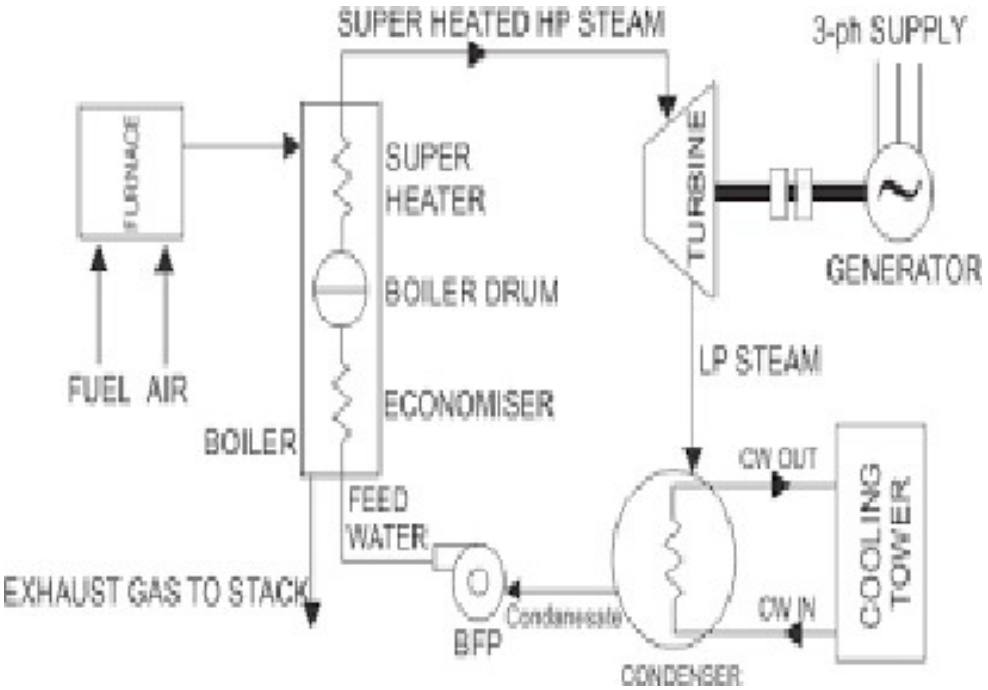
OR



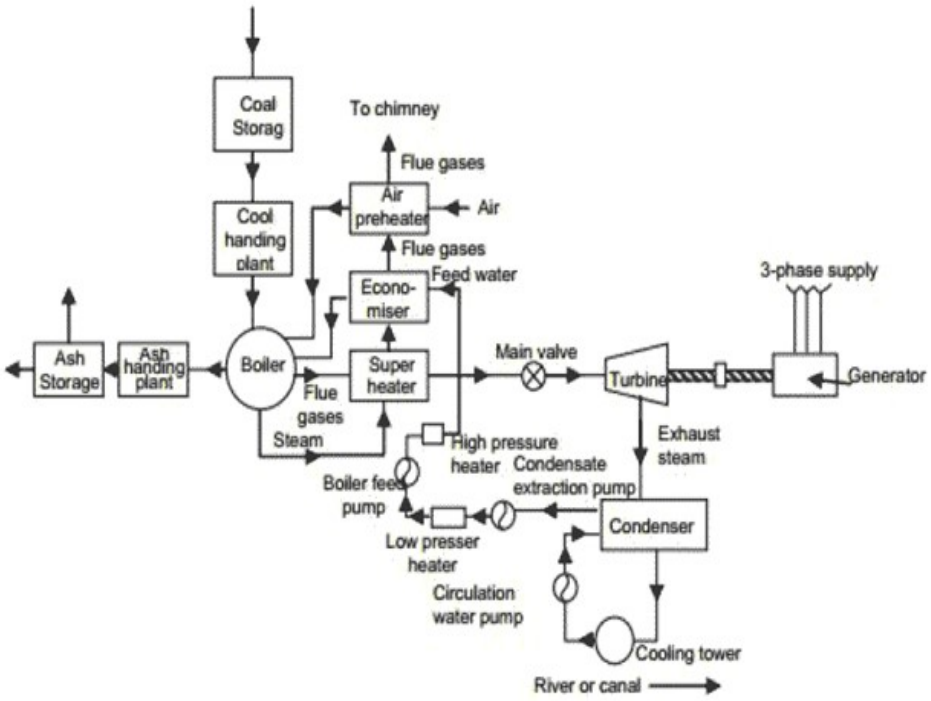
Load Duration Curve

OR Equivalent Figure

Q. 2	Attempt any THREE of the following	12 Marks
a)	Draw a block diagram of thermal power plant.	
Ans:	Block diagram of thermal power plant :	(4 Marks)



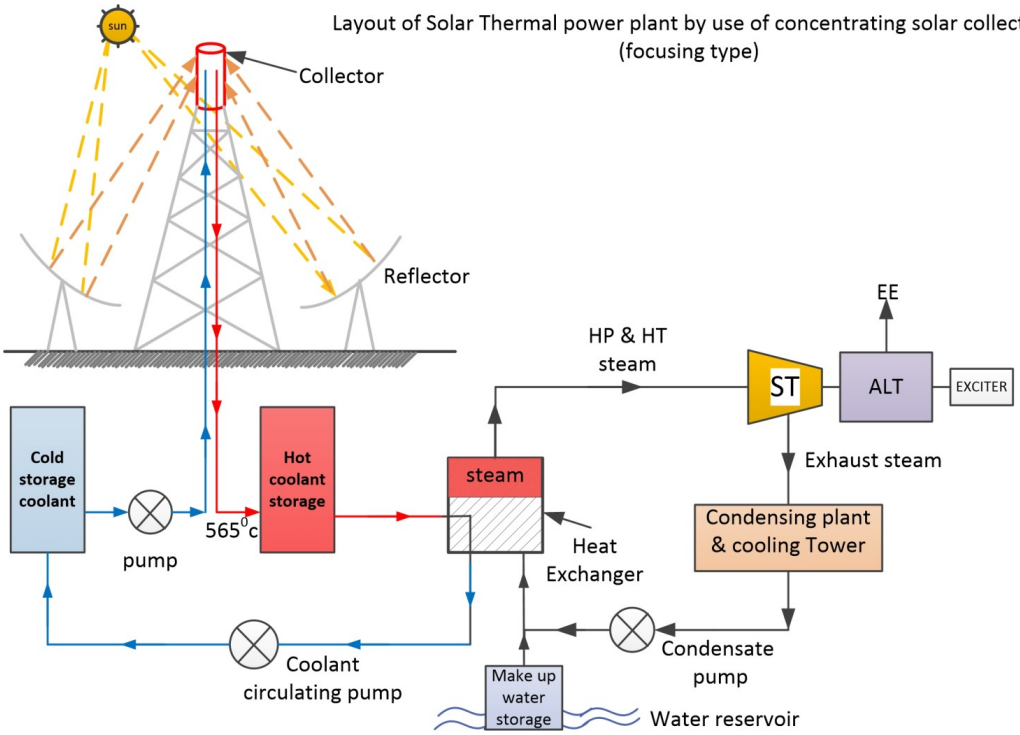
OR Equivalent Figure



b) With a neat diagram explain solar power tower.

Ans: **Diagram explain solar power tower :**

(Diagram : 2 Mark & Explanation : 2 Marks Total 4 Marks)



OR Equivalent Figure

All concentrating solar thermal power (STP) basic elements:

- Concentrator
- Receiver
- Transport-storage (a portion of the thermal energy is stored for later use)
- Steam generator (Heat exchanger)
- Condenser
- Steam turbine
- Alternator

Explanation (Operation):

- The concentrator captures and reflect solar radiation towards collector (absorber)
- The receiver absorbs the concentrated sunlight rays and gets heated.
- The secondary fuel (coolant or working fluid) is passed through collector.
- Transferring its heat energy to a working fluid.

- This coolant gets heated to a very high temperature.
- This hot coolant is stored in transport-storage system (a portion of the thermal energy is stored for later use).Thus solar energy can be used even when sun rays are not available
- Then hot coolant is passed through heat exchanger (steam generator) where steam at high temperature and high pressure is generated.
- This secondary fuel (coolant or working fluid)is re-circulated again and again.
- This steam at high temperature and high pressure is used to run the steam turbine.
- Steam turbine is coupled with alternator which converts mechanical power to electrical energy
- Exhaust steam is condensate in condenser

c) Give the four advantages of vertical axis wind mills.

Ans: **Advantages of vertical axis wind mills:** **(1 Mark each Advantage: Total 4 Marks)**

1. Simple blade design
2. Low cost of fabrication.
3. No yaw controller required.
4. Easy maintenance because ground mounted generator and gear box.

d) Compare base load plant with peak load plant. (any four)

Ans: **(Any Four Point expected : 1 Mark each point Total 4 Marks)**

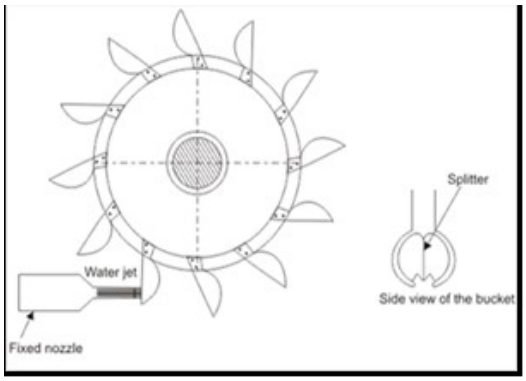
Sr.No.	Points	Base load plant	Peak load plant
1	Definition	The power plant which supplies base load of load curve is known as base load plant	The power plant which supplies peak load of load curve is known as peak load plant
2	Generating capacity	High	Low
3	Firm capacity	High	Low
4	Working Hours	24 hours	Only during peak load hours
5	Cost of generation/ unit	Generally low cost of generation per unit are selected as base load plant	Generally high cost of generation per unit are selected as peak load plant
6	Starting time	Both quick & more starting time power plant can be selected as a base load plant	Quick starting time power plant are selected as a peak load plant

7	Load factor	High	Low
8	Capacity Factor	High	Low
9	Plant use factor	High	Low
11	Examples	Large capacity hydro, thermal, nuclear power station	Small capacity storage hydro, pumped storage hydro, gas, diesel power station.

Q.3 **Attempt any THREE of the following** **12 Marks**

a) **With a neat diagram explain pelton wheel turbine.**

Ans: **Diagram of Pelton Wheel:-** **(Diagram : 2 Marks & Explanation : 2 Marks)**



OR Equivalent Figure

Explanation (Working):

The water stored at high head is made to flow through the penstock and reaches the nozzle of the Pelton turbine.

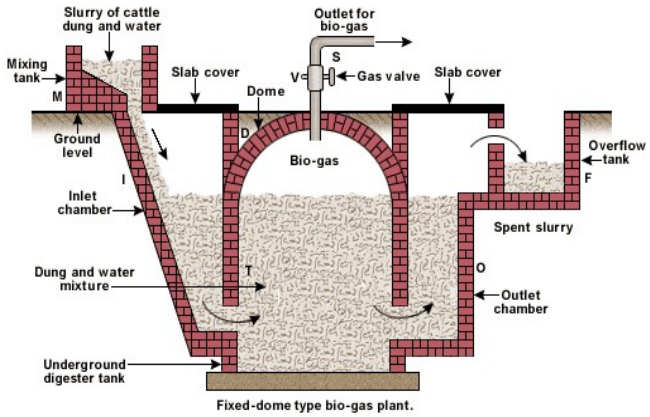
The nozzle increases the K.E. of the water and directs the water in the form of jet.

The jet of water from the nozzle strikes the buckets (vanes) of the runner. This made the runner to rotate at very high speed.

The quantity of water striking the vanes or buckets is controlled by the needle valve present inside the nozzle.

The generator is attached to the shaft of the runner which converts the mechanical energy (i.e. rotational energy) of the runner into electrical energy.

b)	**Draw and explain fixed dome type biogas plant.**
Ans:	**Diagram of fixed dome type biogas plant: (Diagram : 1 Marks & Explanation : 3 Marks)**



Fixed-dome type bio-gas plant.

OR Equivalent Figure

Explanation of layout of biogas plant by the method of fermentation conversion

1. **Foundation :**

Biomass plant consists of pit excavated to desire size & depth, The foundation is nothing but the base of digester. It is made with the help of cement, concrete.

2. **Digester:**

- It is container made up of bricks, sand & cement. Digestor tank is undergrounded to increase the efficiency.
- In the digester, decomposition of biomass takes place due to anaerobic bacteria to produce biogas.
- Quantity of gas produced is depend open type of waste & temperature.

3. **Dome (Balancing Tank) :**

It is the roof of digestor in which biogas is collected.

4. **Mixing Tank:**

It is the tank placed on the top of inlet chamber in which animal, sanitary waste & water are mixed properly to make slurry.

5. **Inlet Chamber:**

It is to admit slurry into digesteor chamber through pipe due to gravity.

6. **Outlet Chambers:**

When generated biogas is high then it increases pressure downwards to slurry. Due to pressure of gas, slurry comes upward automatically through pipe which is

collected in outlet chamber.

The residue (slum) left is used as fertilizer (valuable)

7. Gas Outlet pipe:

It is an outlet pipe fitted at the top of the dome of the digestor to take the biogas for utilization.

The valve is provided to control the flow of biogas.

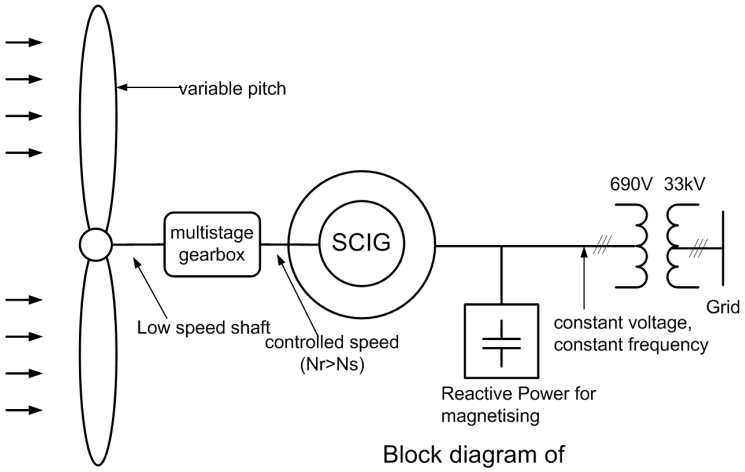
8. Mixing or Stirring:

The decomposition process can be speed up by stirring the slurry from the top of the dome with the help of stirrer which is at digester chamber.

c) Explain Squirrel Cage Induction Generator (SCIG) and also draw a diagram.

Ans: Diagram of Squirrel Cage Induction Generator (SCIG):

(Diagram : 2 Marks & Explanation : 2 Marks)



Block diagram of
Squirrel Cage Induction Generator (SCIG) Wind power plant
(constant speed)

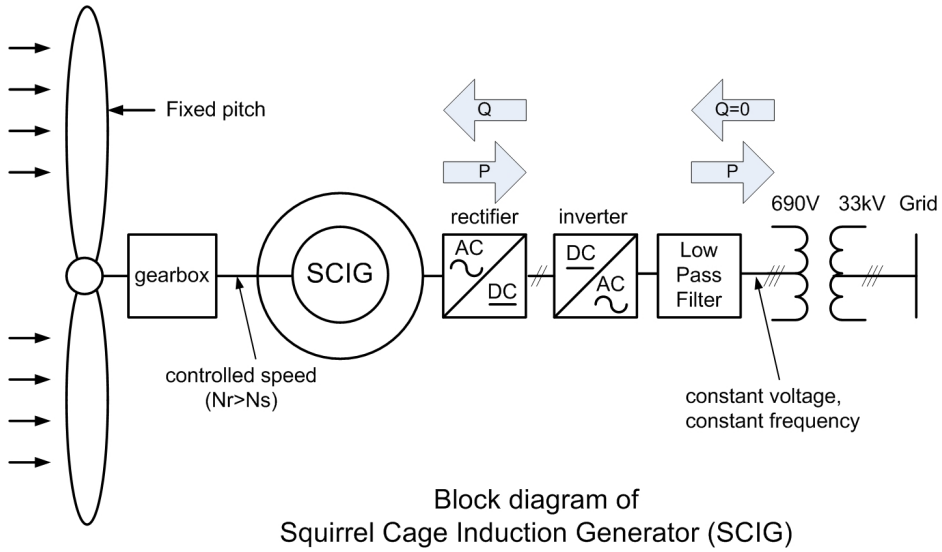
OR Equivalent Figure

Explanation (Operation):-

- In this system multistage gearbox is used to obtain constant speed irrespective of wind speed.
- SCIG require reactive excitation power.
- The SCIG takes the reactive excitation power from a capacitor bank, connected across the stator terminals of the IG

- Rotor of SCIG is rotated at **more than synchronous speed(i.e. low negative slip)** to generate emf (to export power)with the help of wind power.
- Generated voltage is 690 V AC. So it must be step up to 33 KV to connect to power grid.

OR



Block diagram of
Squirrel Cage Induction Generator (SCIG)
Wind power plant (variable speed)

OR Equivalent Figure

Explanation (Operation):-

- In this system gearbox is used to increase the speed of high speed shaft as per design.
- IG require reactive power for excitation.
- Rotor of SCIG is rotated at **more than synchronous speed (i.e. low negative slip) in the variable range** to generate emf with the help of wind power.
- It uses AC-DC-AC power converter (Rectifier, Inverter & Filter) to convert variable frequency, variable voltage output of the generator into the fixed frequency, fixed voltage output required for grid.

d) Explain the choice of size and number of generator units in a power plant.

Ans:

Selection of Size and Number of Generating Units:

(Any Four Point expected : 1 Mark each: Total 4 Marks)

1. The size/rating and number of generating units in such way that they approximately match with the load curve/load duration curve as closely as possible.
2. In order to calculate the size of the units, the station auxiliary load should be taken in

to account.

3. Also the transmission line losses should be considered. It can be approximately taken as 20 % of the consumer load.
4. The future demand and expansion should also be considered as the load on the station always increases.
5. The plant must have some reverse capacity at least 15-20 % more than M.D. under abnormal conditions.
6. Select size/rating of generating units in such way that reliability to maintain supply will be more.
7. Select size/rating of generating units in such way that the plant capacity factor, load factor diversity factor, plant use factor will be more.
8. Select size/rating of generating units in such way that unit almost run at full load or at load which gives maximum efficiency.
9. Select size/rating of generating units in such way that power generation will be economical.
10. Initial and operating cost also to be taken in to account
11. Space required also to be considered.
12. The minimum number of units should be two.
13. As far as possible, the units of equal capacities are selected which will have following advantages.

    i) The parts can be interchanged.
    ii) The maintenance will be easier.
    iii) The working time of each plant regulated.
    iv)The spare parts required to be stored are less.

14. While selecting the size/rating and number of generating units there are two options

    i) To select single generating unit of large capacity
    ii) To select more numbers of small capacity generating unit either of same ratings or different ratings.
    Both options have its own advantages and disadvantages.

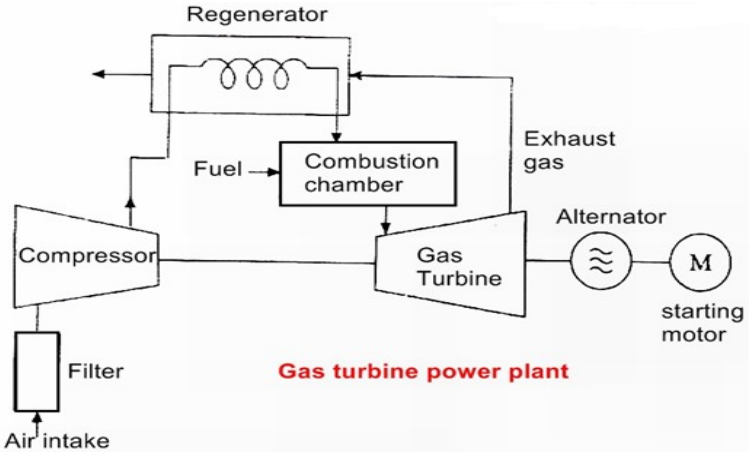
15. In summary,

    Load on the power system is variable where reliability of supply is important so it is neither practicable nor economical to use a single unit of large capacity.

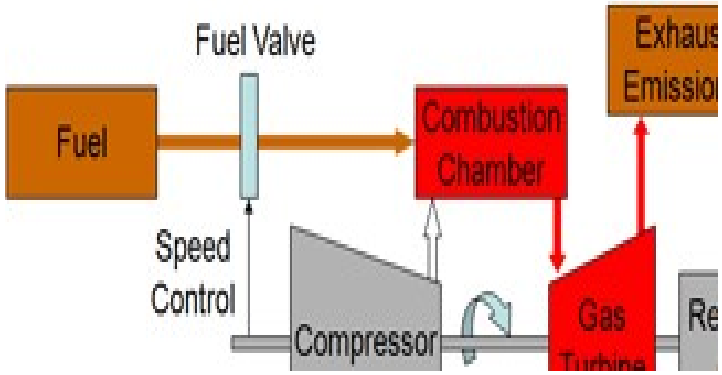
    But, if power plant is connected to grid system then generating unit of higher capacity can be installed.

Q.4	Attempt any THREE of the following	12 Marks
a)	**Draw the schematic arrangement for a gas power plant.**	

Ans: **Schematic arrangement for a gas power plant Simple Systems:-** **(4 Marks)**

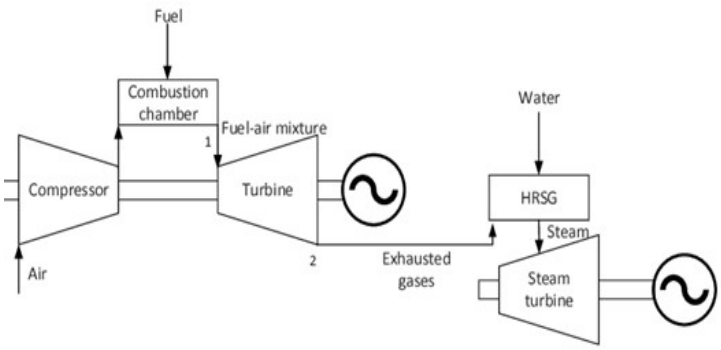


OR Equivalent Figure

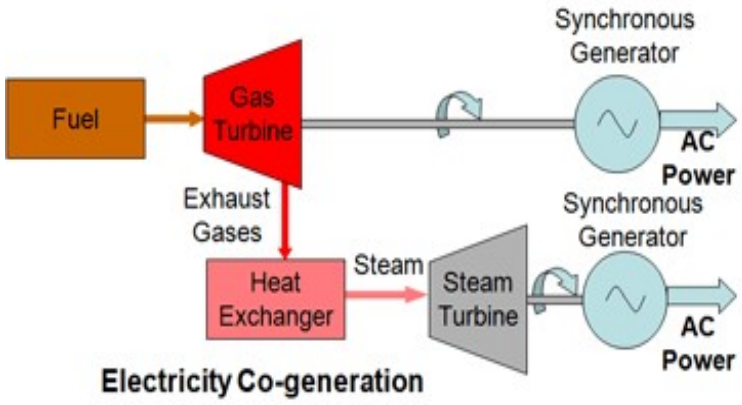


OR Equivalent Figure

Schematic arrangement for a gas power plant Combined Cycle Systems :-



OR Equivalent Figure

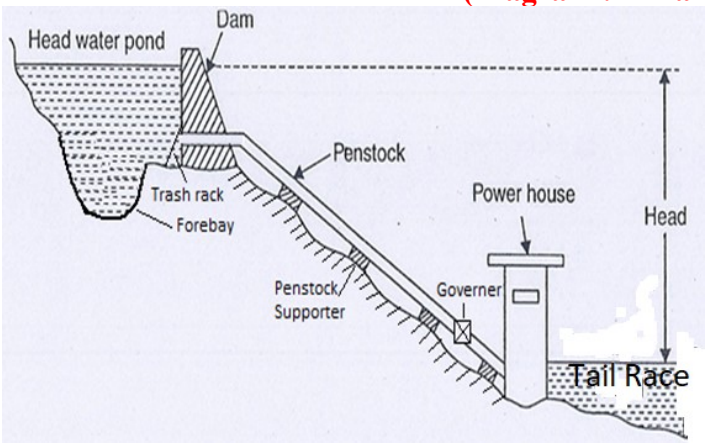


OR Equivalent Figure

b) With a neat diagram explain medium head hydro-electric power plants.

Ans: **Diagram of medium head hydro-electric power plants:**

(Diagram : 2 Marks & Explanation : 2 Marks)

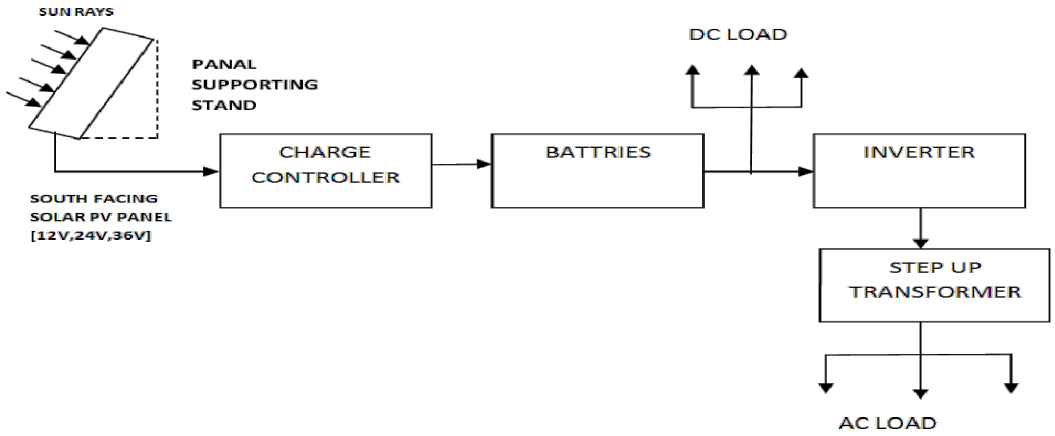


OR Equivalent Figure

Explanation:-

- If head of water is between 30 and 100 m, the plant is called a medium-head plant.
  Potential energy of stored water is medium.
  Larger volume of water is required
- Catchment area of medium capacity is required as water requirement is more.
- The power plant is situated at medium distance from dam.
- There is no surge tank forebay acts as a surge tank.
- Penstocks are of medium length and comparatively medium in diameter
- Francis turbines are normally used.
  Alternator required in these plants is of low speed and large in diameter.

c)	**With a neat diagram explain solar photovoltaic power plant.**
Ans:	**Diagram of solar photovoltaic power plant :** **(Diagram : 2 Marks & Explanation : 2 Marks)**



OR Equivalent Figure

Explanation:

Solar power plant consists of following components:

1. Photovoltaic cell panel:

Its function is to convert sunrays directly into DC electricity.

2.Battery charge Controller:

It protects battery from over charging and it prevents battery from over discharging.

In this way it increases life of storage battery. (OR a charge controller is needed to ensure the battery is neither over nor under-charged)

3.Storage Battery:

Its function is store DC electrical energy generated by P.V. cell which can be used whenever required.

Generally battery having long life are used .There are two types of battery:

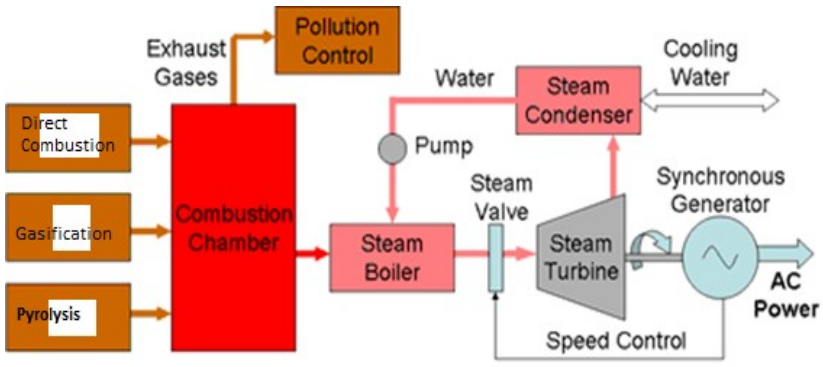
1. Lead acidic battery
2. Nickel cadmium battery

4.Inverter:

It converts DC supply into AC supply.

5. Step-up transformer:

It step-up input voltage to utilization voltage e.g. 230V

d)	**Draw a layout of a thermo-chemical based power plant.**
Ans:	**Layout of a thermo-chemical based power plant:** **(4 Marks)** In this process dry biomass fuels converted to produce gas ,liquid fuels or oil by thermo chemical conversion Thermo-Chemical conversion are of following ways:- 1. Direct combustion 2. Gasification 3. Pyrolysis  **OR Equivalent Figure**
e)	**Define the following term: i) Average demand ii)Load factor iii)Plant capacity factor iv) Plant use factor** **(Each definition 1 mark ,Total 4 Marks)**
Ans:	**i) Average Demand :-** **(1 Mark)** The average of loads occurring on the power station in a given period (day or month or year) is known as Average load or Average demand. **OR** $\text{Daily Average Demand} = \frac{\text{Number of units generated (KWH) in one day}}{\text{Number of hours in a day (24 hours)}}$ **OR** $\text{Monthly Average Demand} = \frac{\textit{Number of units generated (KWH) in month}}{\textit{Number of hours in a month}}$ **OR** $\text{Yearly Average Demand} = \frac{\text{Number of units generated (KWH) in one Year}}{\text{Number of hours in one year}}$

ii) Load Factor: - **(1 Mark)**

It is the ratio of average demand /load to maximum demand during given period is known as Load Factor.

OR

$$\text{Load Factor} = \frac{\text{Average Demand (load)}}{\text{Maximum demand (load)}}$$

OR

$$\text{Daily Load Factor} = \frac{\textit{Number units generated in 1 Day}}{\textit{Number of hours in a day (24 hours)} \times \textit{MaximumDemand}}$$

OR

$$\text{Monthly load Factor} = \frac{\textit{Number of units generated (KWH) in month}}{\textit{Number of hours in a month} \times \textit{Maximum Demand}}$$

OR

$$\text{Yearly load Factor} = \frac{\text{Number of units generated (KWH) in one Year}}{\text{Number of hours in one year (8760H)} \times \text{M.D}}$$

iii) Plant capacity factor: **(1 Mark)**

"The net capacity factor of a power plant is the ratio of its actual output over a period of time, to its potential output if it were possible for it to operate at full nameplate capacity indefinitely.

OR

It is the ratio of actual energy produced (generated) to the maximum possible energy that could have been produced (generated) during a given period.

OR

$$\text{Plant Capacity Factor} = \frac{\text{Energy that is produced}}{\text{Maxium energy that can be produced}}$$

$$\text{Plant Capacity Factor} = \frac{\text{Average demand}}{\text{Plant Capacity}}$$

OR

$$\textbf{Plant capacity factor} = = \frac{\text{Actual energy generated}}{\text{Maximum possible energy (KWH) that could have been generated}}$$

iv) Plant use Factor:- **(1 Mark)**

The definition such that the ratio becomes the amount of energy **used** divided by the maximum possible to be **used**.

It is the ratio of number of unit (kWh) generated to the product of plant capacity and the number of hours for which plant was in operation.

OR

$$i.e\ plant\ use\ factor = \frac{Station\ output\ in\ kWh}{Plant\ capacity \times hours\ of\ use}$$

OR

$$\text{Plant Use Factor} = \frac{\text{Actual energy produced (kWh)}}{\text{Installed Capacity (kW)} \times \text{no. of operation hours(h)}}$$

Or

$$\text{Plant Use Factor} = \frac{\text{Average Demand} \times T}{\text{Installed Capacity} \times \text{no. of operating hours}}$$

Where

$T = 24$ h if the time is a day

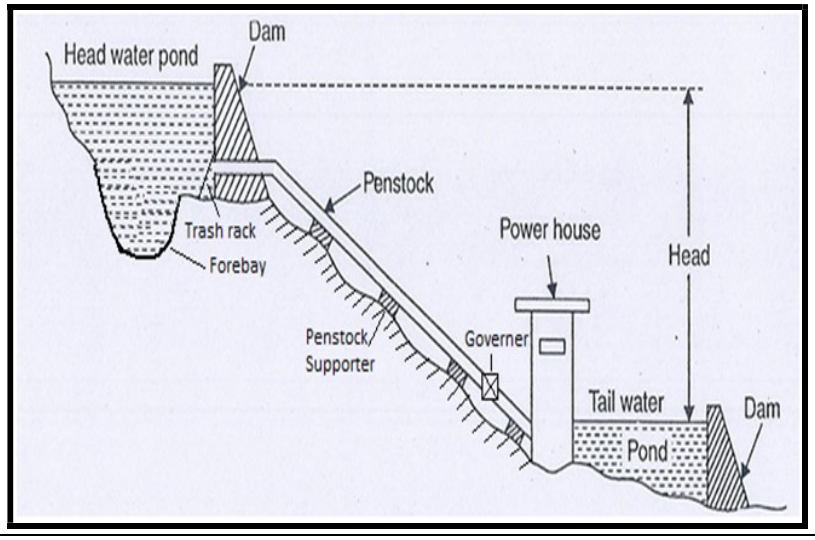
$T = 24 \times 30$ h if the time is a Month

Q.5 **Attempt any TWO of the following** **12 Marks**

a) **With a neat diagram explain pumped storage hydro power plant.**

Ans: **Diagram of pumped storage hydro power plant:**

(Diagram : 3 Marks & Explanation : 3 Marks)



Explanation:

In this power plant, generator is so designed that it Converts mechanical power into electrical power and also works as a motor i.e. converts electrical power into mechanical power And water turbine is so designed that when it is rotated then it works as a centrifugal pump.

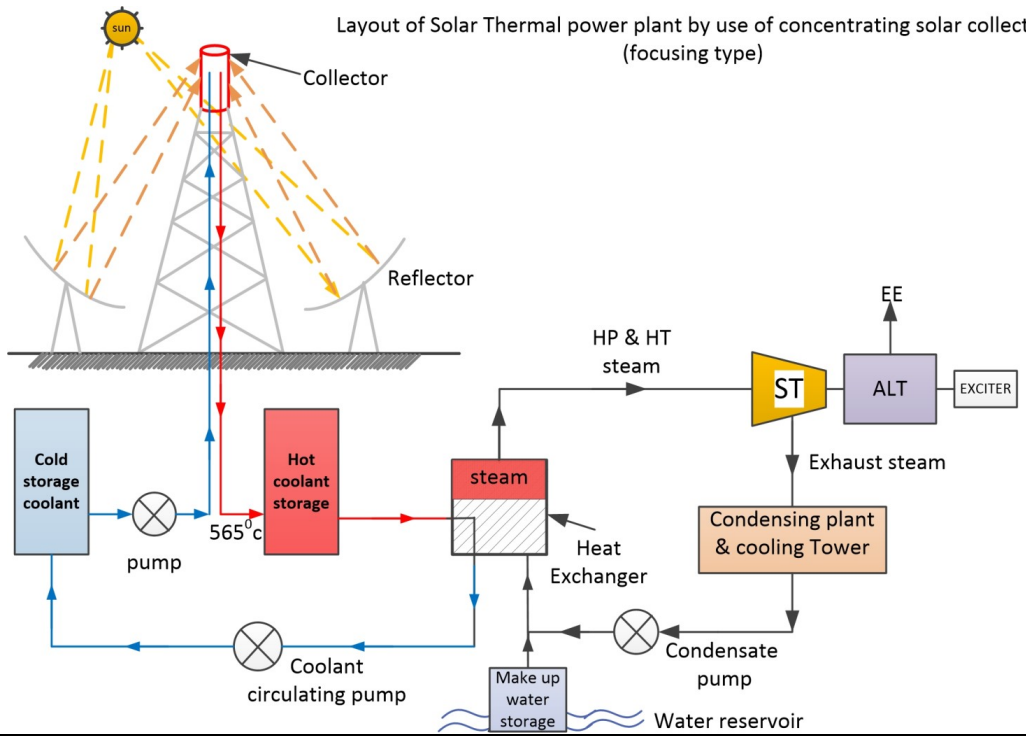
Following are the Advantages of Pumped storage Power Plant (PHPP):

1. It saves water by reusing same water again & again.
2. There is less expenditure during pumping of water because water is pumped when surplus (extra) power is available.
3. It can be put into service immediately; hence it is useful to supply power during peak load period.
4. It increases load factor of power plant
5. It helps in reducing a reserve capacity of PP as it provides additional power during peak load period.

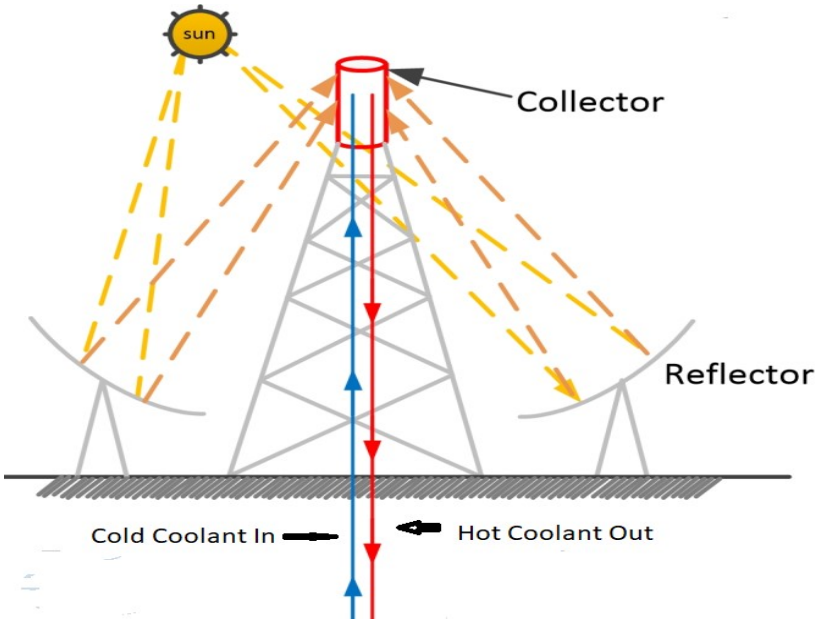
b) Draw a diagram of power tower of concentrated solar power plant.

Ans: **Diagram of power tower of concentrated solar power Plant**:

(Diagram : 6 Marks)



OR



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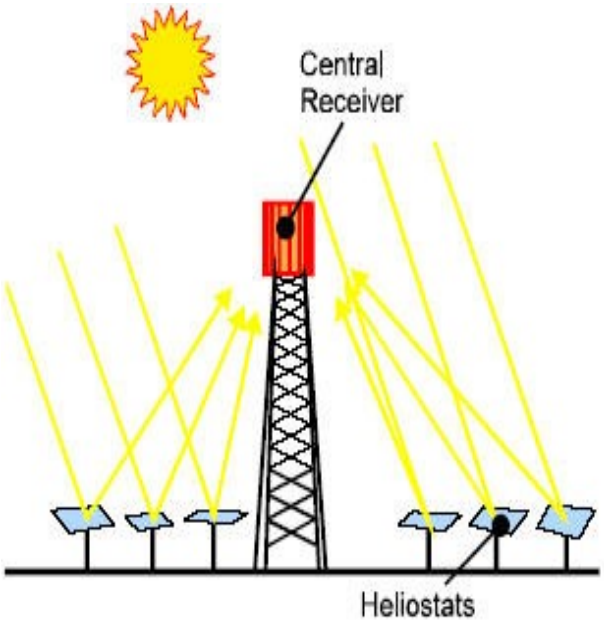


OR Equivalent Figure

c)	**Give the causes and impact and reasons of grid system fault.**
Ans:	**(Any Three Point expected : 1 Mark each point, Total 3 marks)**

Following are the causes/reasons grid system fault:

1. Major imbalance between generation and consumption i.e. demand is more than generation.

2. Low frequency, due to some faults the frequency mismatches i.e (49.5 to 50.3 Hz). If

the frequency is falls or above the permissible limit then, there is possibility of failure of power grid. If fault is not clear in permissible time.

3. Due to breaking of conductor or due to short circuit between two conductors fault occurs which leads to failure of grid. If we cannot clear this fault in less than 1000 millisecond.
4. Power surges causes rapid overheating tends to lead failure of grid.
5. Minor fault in high voltage equipment's if not attended over a period of time results in a total breakdown of equipment suddenly causing grid failure.
6. Illegal utilization of electricity (theft of energy) is also a major reason for power grid failure.
7. Ageing of power equipment's have higher failure rates increases the risk of frequent breakdown.
8. Due to failure of grid connected one of the generator units suddenly.

   Then load is shifted to other generator causes cascade tripping due to over loading.
9. Due to ineffective power delivery planning, co-ordination, supervision and control over generation system causes failure of grid (Due to ineffective work of LDC).

Impact of grid system fault:

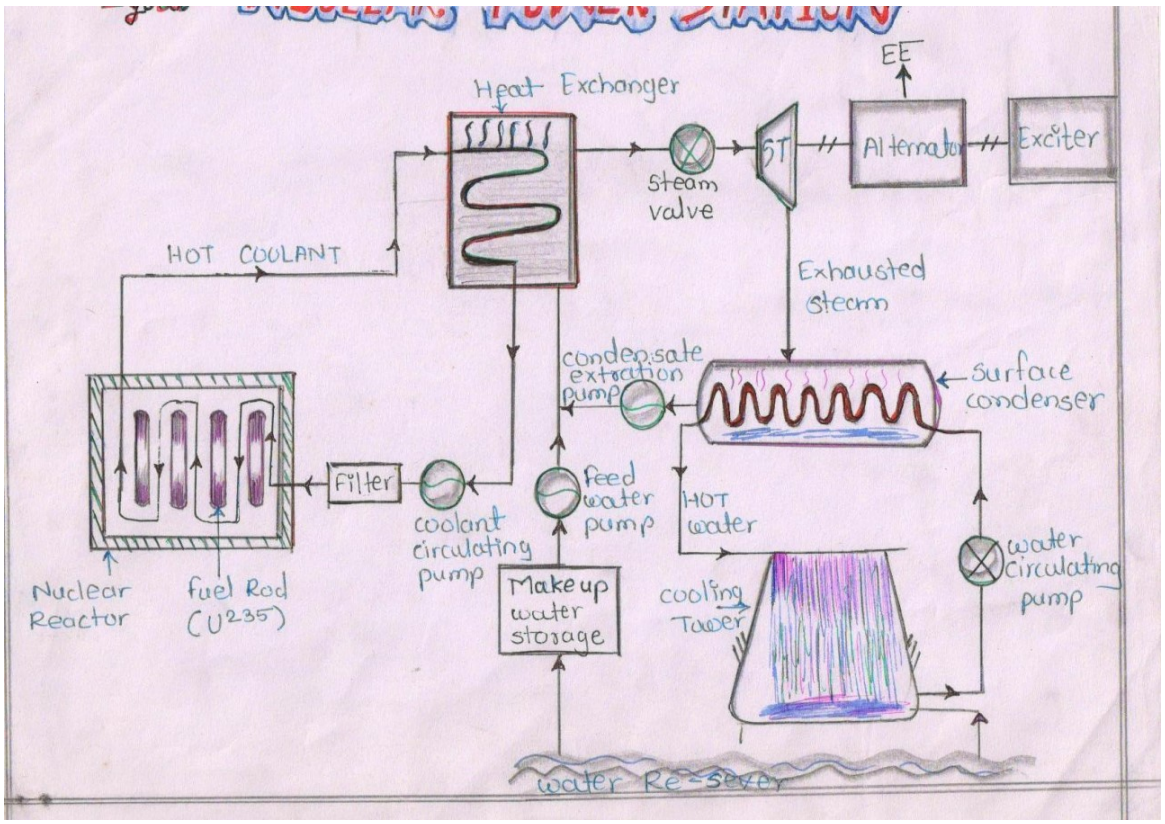
(Any Three Point expected : 1 Mark each point, Total 3 marks)

1. All industries are badly affected due to failure of supply and causes huge losses.
2. All health care centers (Major hospitals) are badly affected due to failure of supply and causes disturbance in treatment on emergency patients.
3. Drinking water supply system are badly affected due to failure of supply and causes insufficient/no water supply.
4. All electrical long route trains, local trains, tramways, metro and railway signal system are badly affected due to failure of supply and causes inconvenience.
5. All communication system is badly affected due to failure of supply and causes inconvenience to people.
6. Disturb the routine work of common all people.

Q.6	**Attempt any TWO of the following** **12 Marks**
a)	**Explain the function of different parts of a typical nuclear power plant with neat sketch.**

Ans: **(Layout 2 Marks, Explanation 4 Marks: Total 6 Marks)**

Diagram of nuclear power plant : **(2 Marks)**



OR Equivalent Figure

Functions of each part of Nuclear power plant:- **(4 Marks)**

1) Nuclear Reactor:

In nuclear reactor the fuel rod of U235 is placed through which tremendous amount of heat energy is liberated due to nuclear chain reaction. (Fission process)

2) Heat Exchanger (Steam generator):

In heat exchanger water is converted into steam at high temperature and high pressure by absorbing heat from hot coolant.

3) Coolant circulating system:

The function of this system is to circulate coolant from reactor core to heat

exchanger. It consists of circulating pump and filter.

4) Condensing Plant:

Function of condenser is to convert exhaust steam again into water by reducing its temperature with the help of cold water. Also it reduces back pressure of steam turbine.

5) Cooling tower:

The function of cooling tower is to reduce the temperature of water coming from condenser.

6) Steam valve**:**

Function of Steam valve (Governor)is to control the flow of steam in such way that speed of turbine remains constant at all loads condition to maintain constant frequency.

7) Steam turbine:

Its function is it converts heat energy into mechanical energy.

To drive alternator this is mechanically coupled with steam turbine.

8) Alternator:

It converts mechanical energy into electrical energy.

---

b) What are the criteria for selection of site for hydroelectric power plant?

Ans: **Following Factors to be kept while site selecting for Hydro power plant:**

(Any Six Point Expected : 1 Mark each Point :Total 6 Marks)

1. It should be located where high rain fall occurs.
2. A large catchments area must be available to store water.
3. It should be located as far as possible in hilly area to reduce construction cost of dam and water reservoir.
4. Stored water should have a reasonable head (Potential Energy).
5. There should be easy access towards the site.
6. Land should have high bearing capacity to reduce the construction cost of dam and for better foundation of machinery.
7. Power plant should be located as far as possible near load center to reduce transmission line cost and losses in it.
8. During the construction of dam, it should be possible to divert the stream of river.
9. The Area should be free from earthquake and natural hazards.
10. It is necessary to see that water is of good quality (i.e.no chemical impurities) because

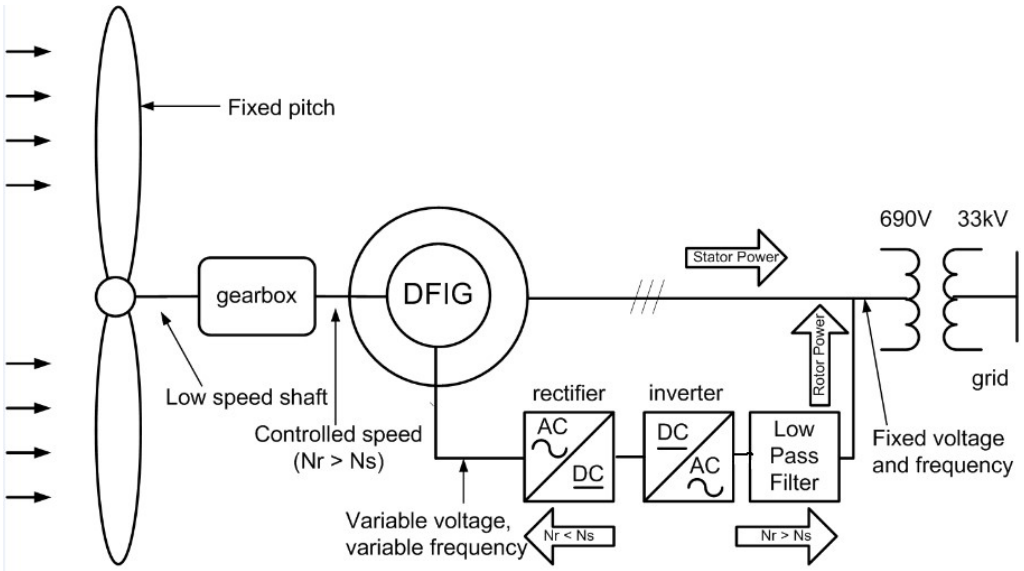
polluted water may cause corrosion.

11. The catchment area should be such that there are less accumulation of slit and debris (Solid Impurities).
12. Cost of land should be less.
13. Skilled and unskilled man power should be available nearby.

c) With a neat diagram explain doubly fed induction generator (DFIG).

Ans: **(Layout 3 Marks, Explanation 3 Marks, Total 6 Marks)**

Diagram of Doubly fed induction generator (DFIG): **(3 Marks)**



OR Equivalent Figure

Explanation :- **(3 Marks)**

- DFIG can feed power through the stator as well as rotor to the grid.
- The stator is directly connected to the fixed frequency grid while rotor is connected via bi-directional back-to-back converters.
- If the generator is running super-synchronously (i.e. N_R speed is greater than N_S speed), the electrical power is delivered by both the rotor and the stator to the grid.
- If the generator is running sub-synchronously (i.e. N_R speed is less than N_S speed) the electrical power is delivered to the rotor from the grid.
- Generated voltage is 690 V AC. So it must be step up to 33 KV to connect to power grid.

----------END----------

22327

21819

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Define fission and fusion related to nuclear fuel.

b) Classify hydropower plant on the basis of water head and state turbine used for them.

c) State any two advantages of Kaplan turbine over Francis turbine.

d) List different types of concentrating type solar collectors.

e) State the various types of Biomass Resources.

f) State range of wind speed is considered favorable for wind power generation.

g) Define the term ‘‘cold reserve’’ and ‘‘hot reserve’’.

Marks

2. Attempt any THREE of the following: **12**

a) Describe Nuclear Hazards and various ways of disposal of nuclear waste.

b) Draw schematic arrangement of hydro electric power station and describe energy conversion process of hydro power plant.

c) Describe main features of various types of generators and their suitability w.r.t wind power generation.

d) State the causes and impacts of state grid system fault.

3. Attempt any THREE of the following: **12**

a) Compare fire tube and water tube boilers used in thermal power plants.

b) Describe safe practices for hydro power plants.

c) Describe with layout the working of solar Photo Voltaic (PV) power plant.

d) State the various problems caused during operation of large wind power generators.

4. Attempt any THREE of the following: **12**

a) Draw schematic arrangement of diesel engine power station and important systems and essential components of diesel plant

b) Explain layout of thermo-chemical based (Municipal waste) power plant.

c) Compare Horizontal axis and vertical axis wind machine on the basis of

(i) Power captured for the same tower height.

(ii) Noise problem.

(iii) Complexity of design and yaw mechanism

(iv) Effect of fatigue arising from numerous resonance in structure.

Marks

d) Define the terms:

(i) Load factor

(ii) Diversity factor

(iii) Demand factor

(iv) Plant capacity factor.

e) Explain how load curves helps in the selection of size and number of generating units.

5. Attempt any TWO of the following: **12**

a) Explain with layout the working of typical thermal power plant with steam turbines and electric generators.

b) Explain with neat sketch the construction and working of pelton turbine used in hydro power plant.

c) Explain with neat sketch, layout of Bio-chemical based (biogas) power plant.

6. Attempt any TWO of the following: **12**

a) Draw the layout of typical micro hydro scheme and describe potential locations of micro-hydro power plants in Maharashtra.

b) Explain with layout, the working of parabolic trough collector concentrated solar power plants.

c) A load on a power plant on a typical day is as under:-

Time	12-5 AM	5-9 AM	9-6 PM	6-10 PM	10PM-12AM
Load in MW	20	40	80	100	20

Plot the chronological load curve and load duration curve. Find the load factor of the plant and energy supplied by the plant in 24 hours.

Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any FIVE of the following**	**10 Marks**
a)	**Define fission and fusion related to nuclear fuel.**	
Ans:	**1.** By breaking up heavy nuclei into nuclei of intermediate size, **the process being known as fission.** **(1 Mark)** **OR** The process in which heat energy is released without using oxygen for combustion in process **is known as nuclear Fission.** **2.** By combining light nuclei, **the process being known as fusion.** **(1 Mark)** **OR** Fusion is the fussing of two or more small atoms into a larger one to, produces heat energy.	
b)	**Classify hydropower plant on the basis of water head and state turbine used for them.**	
Ans:	**Classification the hydro-electric plants According to availability of Head of Water:** **(1 Mark)** 1. Very high head power plant 2. High head power plant 3. Medium head power plant 4. Low head power plant	

	Following types of turbine used in hydro power plant: **(1 Mark)** 1. Pelton wheel for Very high head power plant and High head power plant (300 mtr. And above) 2. Francis Turbine for high head power plant and medium head power plant (Up to 300 mtr.) 3. Kaplan Turbine for Low head power plant (below 40-15 mtr.) 4. Propeller Turbine for Low head power plant (below 15 mtr.)
c)	**State any two advantages of Kaplan turbine over Francis turbine.**
Ans:	**Advantages of Kaplan turbine over Francis turbine:-** **(Any Two advantages expected: 1 Mark each, Total: 2 Marks)** 1. Runner vanes are adjustable 2. Very low head of water is required 3. It has very small number of blades 3 to 8 4. Very less resistances have to be over come 5. Position of shaft is only in vertical direction so space required is less 6. In this turbine the speed of the rotor is much greater than the speed of the water, almost double.
d)	**List different types of concentrating type solar collectors.**
Ans:	**Following types of concentrating type solar collectors:** **(Any TWO Point expected : 1 Mark each point, Total 2 Marks)** 1. Non- concentrating Type:- a) Flat plate collectors (FPC) b)Evacuated Tubular collector (ETC) 2. Concentrating type collectors (focusing type collector): a) Line Focusing: - Linear cylindrical Parabolic (troughs) concentrating collector (CC) b) Point Focusing: - • Central receiver Spherical (Dish) Parabolic concentrating Collector (CC) • Central receiver solar tower with number of distributed Concentrating collector

e)	**State the various types of Biomass Resources.**
Ans:	**Following are the various types of Biomass Resources:-** **(Any Four types expected: 1/2 mark each, Total: 2 Marks)** 1. Bagasse 2. Agriculture residual 3. Forestry residual 4. Energy trees/ crop plantation 5. Dead trees and tree branches 6. Wood processing industrial waste 7. Food processing industrial waste 8. Residential, commercial and industrial waste 9. Peel 10. Coconut shell , ground nut shell 11. Vegetables waste 12. Animal waste 13. Sanitary waste 14. molasses waste 15. Fishery waste 16. Sewage 17. Manure etc.
f)	**State range of wind speed is considered favorable for wind power generation.**
Ans:	**Range of wind speed is considered favorable for wind power generation is:-** **(2 Marks)** ➢ **14.4 to 16.2 Km/hour**
g)	**Define the term "cold reserve" and "hot reserve".**
Ans:	**i) Cold reserves:** **(1 Mark)** It is stand by generating capacity which is available for service but not in operation. **ii) Hot reserve:** **(1 Mark)** It is reserve generating capacity, in operation but not in service (not connected to busbar/grid)

Q. 2	Attempt any THREE of the following	12 Marks
a)	Describe Nuclear Hazards and various ways of disposal of nuclear waste.	

Ans:

➢ **Nuclear hazards**: **(2 Marks)**

The waste produced in nuclear power plant is in the form of solid, liquid & gases, these are radioactive. **These are very harmful to human being, animals, environment and nature, if it is not carefully disposed off.**

➢ **Various ways of disposal of nuclear waste:-**

(Any TWO Point expected : 1 Mark each point, Total 2 Marks)

➢ Solid Waste Disposal:-

- Solid wastes removed from the reactor are very hot and radioactive.
- Solid waste is filled in a sealed container.
- And is kept under water for 5 to 10 years under supervision to reduce its temperature.
- The solid waste container is buried deeply in the ground by making tunnel, however the area must be unused land, away from populated area and there is less rain fall in that area.

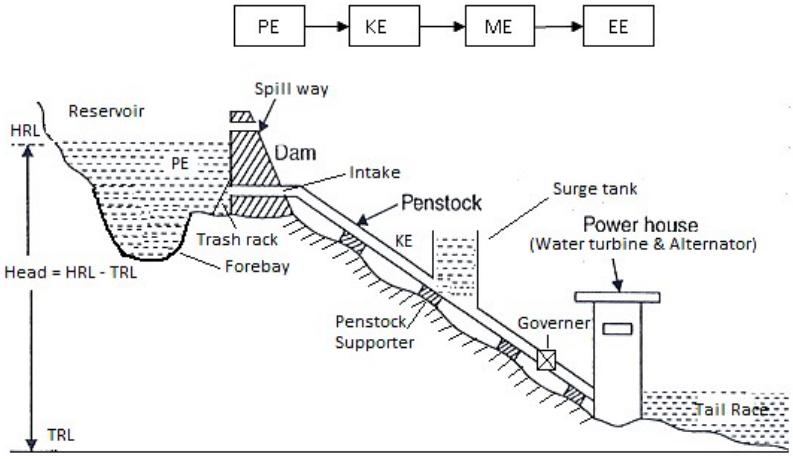
➢ Liquid Waste Disposal:-

- The liquid waste is diluted to a sufficient level by adding large quantity of water.
- The liquid waste after analysis (concentration of radioactive material are measured.) is sealed in a container.
- Then it is disposal off into the sea, several kilometers away from sea shore.

➢ Gaseous Waste Disposal:-

- Gaseous wastes are generally diluted with adding air.
- And passed through high efficiency filter.
- Then passed through radiation monitoring system.
- In this system concentration of radioactive material are measured.
- If it is safe then released to atmosphere at high level through large height chimney.

b)	**Draw schematic arrangement of hydroelectric power station and describe energy conversion process of hydro power plant.**
Ans:	**Schematic arrangement of hydroelectric power station:-** **(Schematic arrangement : 2 Marks & Energy conversion process: 2 Marks)**



or equivalent arrangement

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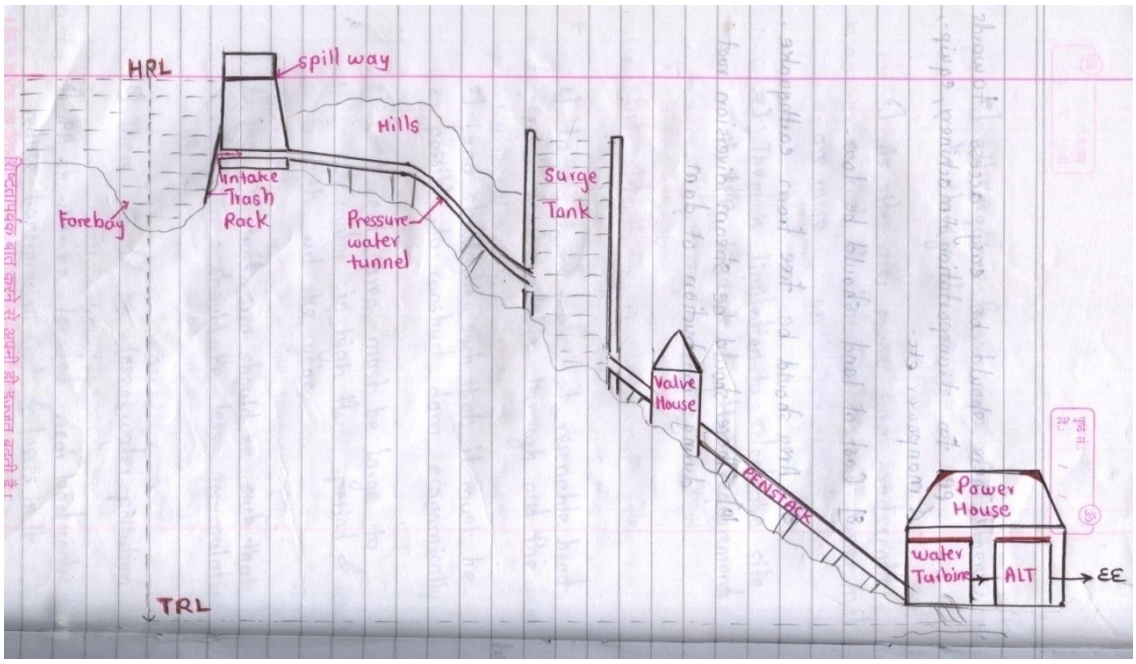


Energy conversion process of hydro power plant:-

Water stored at high level by constructing dam across river. This stored water has potential energy. This stored water is passed to run the water turbine which is

	located at lower level through penstock. Thus potential energy of water is converted into kinetic energy in penstock and turbine converts kinetic energy into mechanical energy and Alternator is coupled to water turbine which converts mechanical energy into electrical energy.
c)	**Describe main features of various types of generators and their suitability w.r.t wind power generation.**
Ans:	**Main features of various types of generators for wind power generation :-** **(Any TWO Point expected : 1 Mark each point, Total 2 Marks)** 1. Generator should be robust in construction 2. It should have less maintenance and long life 3. It should have high efficiency 4. Generator may be AC or DC. 5. Generator may be constant speed or variable speed. 6. Gearbox used may be single stage or multistage. 7. Some generators are direct driven (No gear box) 8. Synchronous generators are using permanent magnets (PM) did not require external DC excitation 9. Synchronous generators required external DC excitation if PM are not used 10. Induction Generators requires reactive power for excitation. In case of standalone loads, a capacitor bank is used to provide the magnetising current and hence establish the magnetizing flux. If it is connected to the electrical grid, then the magnetizing current is taken from the grid. 11. For variable voltage and variable frequency output of generators AC-DC-AC power converters are used to obtain constant voltage and constant frequency supply. 12. The power output of generator (690V as a rated voltage value) fed to a transformer, which converts to the typically 33 kV. **Suitability w.r.t wind power generation:-**

	(Any TWO Point expected : 1 Mark each point, Total 2 Marks) 1. Salient poles are more used in low-speed machines and therefore may be the most useful version for application to direct-drive wind turbines. 2. In small wind turbines SCIG are used and 3. For large wind turbine doubly fed induction generators are used **4.** For small capacity PMSG are used **5.** Now a days large capacity wind turbine uses multi pole permanent magnets (PM) direct driven (No gear box) synchronous generators **6.** Variable speed Generator is preferred over constant speed generator.
d)	**State the causes and impacts of state grid system fault.**
Ans:	**(Causes 2 Marks and Impacts 2 Marks)** **Following are the causes state grid system fault:** **(Any TWO Point expected : 1 Mark each point, Total 2 Marks)** 1. Major imbalance between generation and consumption i.e. demand is more than generation. 2. Low frequency, due to some faults the frequency mismatches i.e. (49.5 to 50.3 Hz). If the frequency is falls or above the permissible limit then, there is possibility of failure of power grid. If fault is not clear in permissible time. 3. Due to breaking of conductor or due to short circuit between two conductors fault occurs which leads to failure of grid. If we cannot clear this fault in less than 1000 millisecond. 4. Power surges causes rapid overheating tends to lead failure of grid. 5. Minor fault in high voltage equipment's if not attended over a period of time results in a total breakdown of equipment suddenly causing grid failure. 6. Illegal utilization of electricity (theft of energy) is also a major reason for power grid failure. 7. Ageing of power equipment's have higher failure rates increases the risk of frequent breakdown.

8. Due to failure of grid connected one of the generator units suddenly.

   Then load is shifted to other generator causes cascade tripping due to over loading.

9. Due to ineffective power delivery planning, co-ordination, supervision and control over generation system causes failure of grid (Due to ineffective work of LDC).

Impact of state grid system fault:

(Any TWO Point expected : 1 Mark each point, Total 2 Marks)

1. All industries are badly affected due to failure of supply and causes huge losses.
2. All health care centers (Major hospitals) are badly affected due to failure of supply and causes disturbance in treatment on emergency patients.
3. Drinking water supply system are badly affected due to failure of supply and causes insufficient/no water supply.
4. All electrical long route trains, local trains, tramways, metro and railway signal system are badly affected due to failure of supply and causes inconvenience.
5. All communication system is badly affected due to failure of supply and causes inconvenience to people.
6. Disturb the routine work of common all people.

Q.3 Attempt any THREE of the following 12 Marks

a) Compare fire tube and water tube boilers used in thermal power plants.

Ans:

(Any Four Point expected : 1 Mark each point Total 4 Marks)

Sr.No.	Fire tube Boilers	Water tube Boilers
1	In fire tube boilers hot gases are passed through the tubes and water surrounds these tubes.	In these boilers water is inside the tubes and hot gases are outside the tubes.
2	Steam at low pressure and low temperature is generated.	Steam at high pressure and high temperature is generated.
3	Rate of steam generation per hour is less.	Rate of steam generation per hour is more.
4	Steaming time is very more.	Steaming time is very less.

5	The output of the boiler is not high.	The output of the boiler is high.
6	Low efficiency.	High efficiency.
7	Less control on temperature of steam.	Better control on temperature of steam.
8	Not respond quickly to change in steam demand.	Respond quickly to change in steam demand.
9	Its weight is more.	Its weight is less.
10	Less risk of explosion due to low pressure.	Risk of explosion is more due to high pressure.
11	Not suitable for large capacity thermal power plant.	Suitable for large capacity thermal power plant.

b) Describe safe practices for hydro power plants.

Ans: **Following are the safe practices:-**

(Any four point expected: 1 Mark each, Total : 4 Marks)

1. The Personal Protective Equipment (PPE) / protective devices made available for individual or collective use of the workers likely to be affected by the hazards of the workplace or process.
2. Not to allow any worker to work in an unsafe condition, nor with unsafe equipment
3. Sufficient number of Supervisors shall be appointed for adequate and constant supervision at all times and in all workplaces
4. All workers are protected from the hazards, arising out of their work or due to the work carried out by others, in the vicinity
5. Safety training shall be provided to all employs Appoint a Safety Officers with the qualifications and experience
6. Safety posters, slogan competition, special meetings and talks shall be organized.
7. Emergency action plan should be ready to deal with fire and explosion
8. Power plant should be protected against lightning stroke i.e. use appropriate type of lightning arrestor.
9. Barricades, warning sign, safety posters should be provided to hazards and important locations

10. Station should have at least two independent ways to exit. If one route becomes inaccessible, an alternative emergency escape route should always be available. Adequate lighting is essential for emergency escapes.
11. During flood there should be provision of automatically stop the hydro plant.
12. Plant should be inspected from OSHA and NFPA organization

OR

Following are the different protection provided to HPP for safety:-

1. Fore bay:-

It serves the following function is-

- It store rejected water immediately when load on turbine reduces so it avoid water hammer effect in penstock and protect the penstock.
- It avoids cavity effect in penstock when load on turbine increases (Because it immediately supplies the water).
- It acts as buffer storage of water during flooding which increases the safety of dam.

2. Trash rack (Screen/ Booms):-

- It avoids entry of debris (solid particles, large fish, and ice) going towards the turbine.
- It avoids choke up of penstock and damage to turbine.

3. Spillways: -

- It discharge excess water from reservoir when the water exceeds the storage capacity of reservoir.
- It avoids damage to dam due to excess pressure of water.
- It acts as a safety valve to the dam.

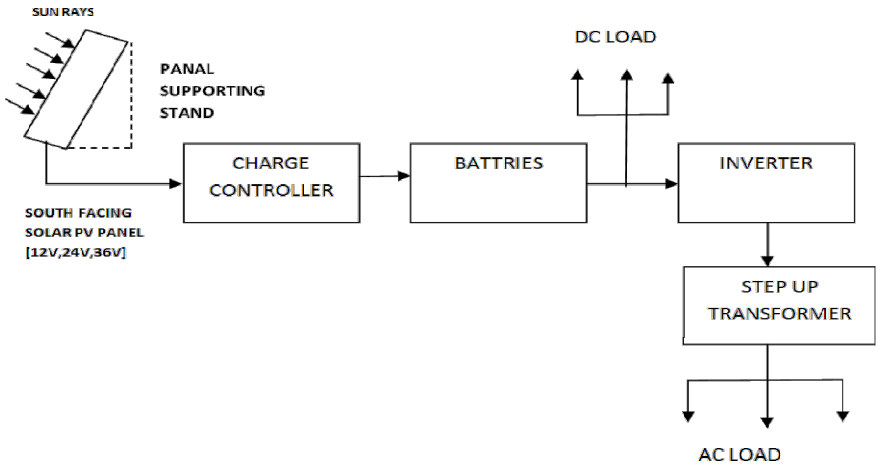
4. **Protection provided to penstock**:

- Surge Tank or fore bay
- Automatic butterfly valve
- Air valve

5. **Surge tank:-** –

- It protects penstock from water hammer effect when load on turbine reduces (Because it immediately stores the rejected water).
- It avoids cavity effect in penstock when load on turbine increases (Because it immediately supplies the water).

c)	Describe with layout the working of solar Photo Voltaic (PV) power plant.
Ans:	**Diagram of solar photovoltaic power plant :** **(Layout : 2 Marks & working : 2 Marks, Total : 4 Marks)**



OR Equivalent Figure

Working:-

1. Photovoltaic cell panel:

Its function is to convert sunrays directly into DC electricity.

2.Battery charge Controller:

It protects battery from over charging and it prevents battery from over discharging. In this way it increases life of storage battery. (OR a charge controller is needed to ensure the battery is neither over nor under-charged)

3.Storage Battery:

Its function is store DC electrical energy generated by P.V. cell which can be used whenever required.

Generally battery having long life are used .There are two types of battery:

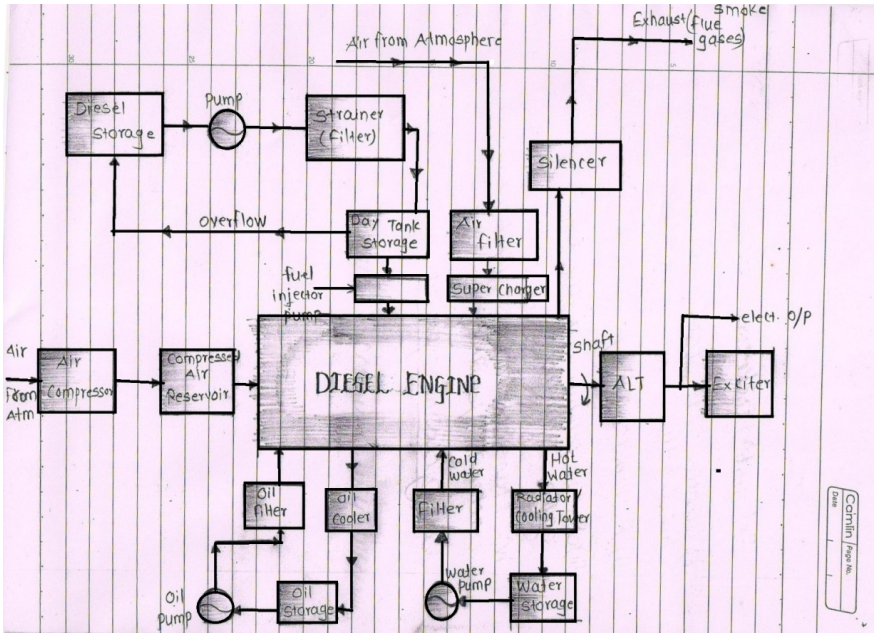
1. Lead acidic battery
2. Nickel cadmium battery

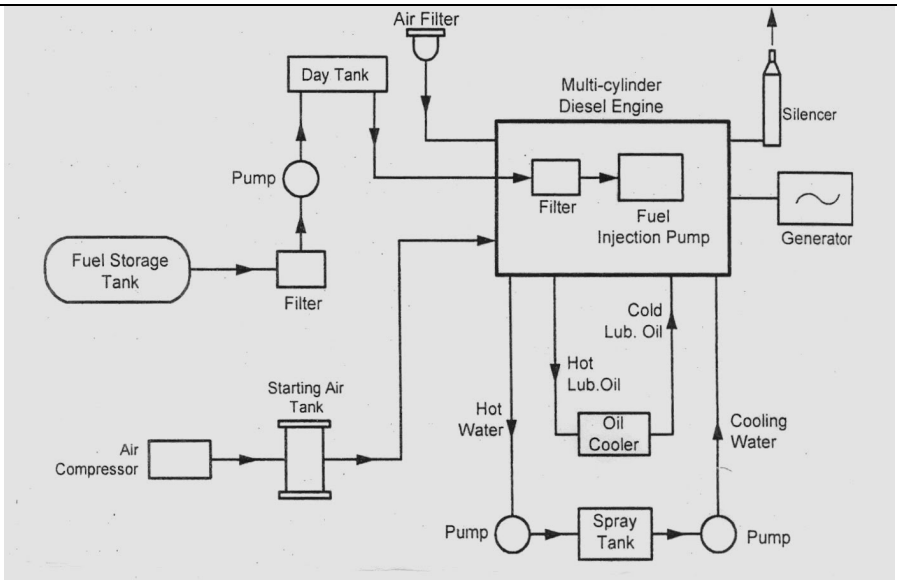
4.Inverter:

It converts DC supply into AC supply.

5. Step-up transformer:

It step-up input voltage to utilization voltage e.g. 230V

d)	**State the various problems caused during operation of large wind power generators.**
Ans:	**Following are the various problems caused during operation of large wind power generators: (Any four point from following or equivalent are expected: 1 Mark each, Total : 4 Marks)** 1. Wind turbine produces noise during operation 2. It kills the large birds and bats some time when the birds collide to the turbine blades 3. Wind turbine structures, can interfere with communication / radar signals when these signals interrupted by the turbine structure or the rotor. 4. Wind turbines can cause problems with television reception 5. Wind turbine produces Shadow flicker can be annoying (disturbing) when the shadow of moving turbine blades fall on a house/ground at certain times of the day and year. 6. Output voltage content harmonics if converters are used 7. The regular blocking and unblocking of the direct sun-light by the rotating turbine blades.
Q.4	**Attempt any THREE of the following 12 Marks**
a)	**Draw schematic arrangement of diesel engine power station and important systems and essential components of diesel plant**
Ans:	**Schematic arrangement of diesel engine power station :** **(Schematic arrangement: 2 Mark & Essential Components: 2 Mark. Total 4 Marks)**  **OR equivalent figure**



Essential components of diesel plant:-

1) Diesel Engine
2) Engine air intake system
3) Engine fuel System
4) Engine exhaust system
5) Engine cooling System
6) Engine Lubricating System
7) Engine starting system
8) Flywheel
9) Governor
10) Alternator

b) Explain layout of thermo-chemical based (Municipal waste) power plant.

Ans: **(Explain 2 Marks and layout 2 Marks)**

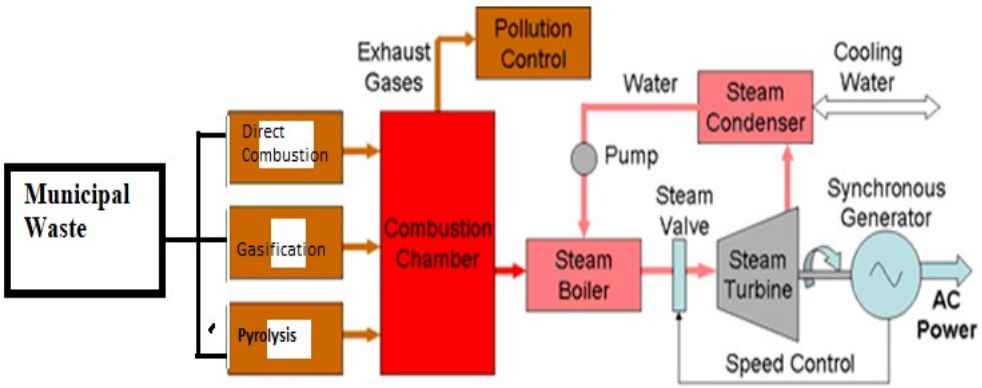
Explanation of Thermo chemical based (municipal waste PP):- **(2 Marks)**

In this process dry municipal waste (biomass fuels) is converted to produce gas, liquid fuels or oil by thermo chemical conversion Thermo-Chemical conversion are of following ways:-

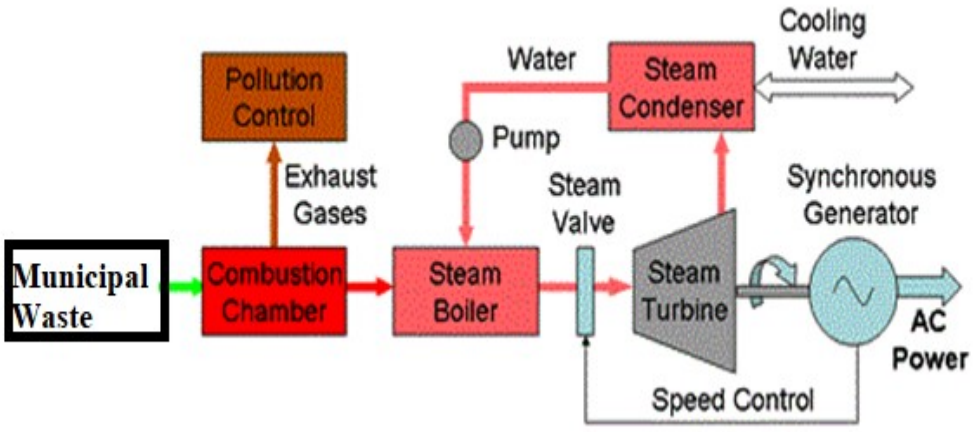
1. Direct combustion
2. Gasification
3. Pyrolysis

Which can be used to produce heat energy. This heat energy is used to produce high pressure and high temperature steam. This steam is used to run the steam turbine. Steam turbine is coupled with generator to produce electrical energy.

Layout of a thermo-chemical based power plant: **(2 Marks)**



OR Equivalent Figure



c) **c) Compare Horizontal axis and vertical axis wind machine on the basis of : (i) Power captured for the same tower height. (ii) Noise problem. (iii) Complexity of design and yaw mechanism (iv) Effect of fatigue arising from numerous resonance in structure.**

Ans: **(1 Mark each point Total 4 Marks)**

Sr.No.	Points	Horizontal axis Wind Machine	vertical axis wind machine
i)	**Power captured for the same tower height.**	More	Less
ii)	**Noise problem**	Noise in operation	Quite in operation
iii)	**Complexity of design and yaw mechanism**	Complicated in design and Yaw mechanism is required.	Simple in design and Yaw mechanism is not required.
iv)	**Effect of fatigue arising from numerous resonance in structure.**	Less	More

d) **Define the terms: (i) Load factor (ii) Diversity factor (iii) Demand factor (iv) Plant capacity factor.**

Ans: **(Each definition 1 Mark)**

i) Load Factor: - **(1 Mark)**

It is the ratio of average demand /load to maximum demand during given period is known as Load Factor.

OR

$$\text{Load Factor} = \frac{\text{Average Demand (load)}}{\text{Maximum demand (load)}}$$

OR

$$\text{Daily Load Factor} = \frac{Number\ units\ generated\ in\ 1\ Day}{Number\ of\ hours\ in\ a\ day\ (24\ hours) \times Maximum Demand}$$

OR

$$\text{Monthly load Factor} = \frac{Number\ of\ units\ generated\ (KWH)\ in\ month}{Number\ of\ hours\ in\ a\ month\ \times Maximum\ Demand}$$

OR

$$\text{Yearly load Factor} = \frac{\text{Number of units generated (KWH) in one Year}}{\text{Number of hours in one year (8760H)} \times \text{M.D}}$$

ii) Diversity Factor:- **(1 Mark)**

The ratio of the sum of the individual consumers, maximum demand to the maximum demand on power station.

OR

$$\textbf{Diversity Factor} = \frac{\text{Sum of individual consumers max imum demand}}{\text{Maximum demand on power station}}$$

iii) Demand factor: **(1 Mark)**

It is the ratio of maximum demand on the power station to its connected load.

OR

Mathematical expression:

$$\textbf{Demand Factor} = \frac{\text{Maximum Demand}}{\text{Connected load}}$$

iv) Plant capacity factor: **(1 Mark)**

"The net capacity factor of a power plant is the ratio of its actual output over a period of time, to its potential output if it were possible for it to operate at full nameplate capacity indefinitely.

OR

It is the ratio of actual energy produced (generated) to the maximum possible energy that could have been produced (generated) during a given period.

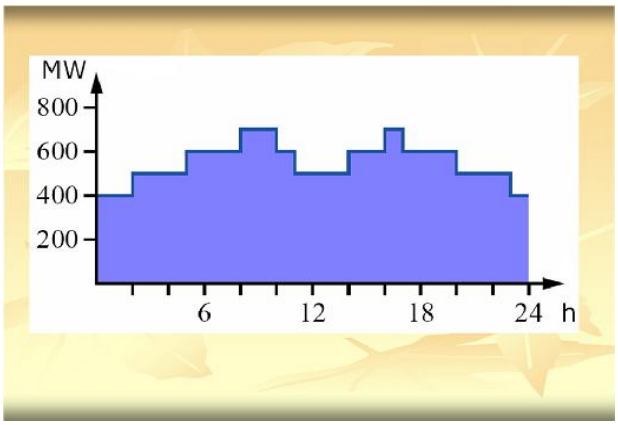
OR

$$\text{Plant Capacity Factor} = \frac{\text{Energy that is produced}}{\text{Maxium energy that can be produced}}$$

$$\text{Plant Capacity Factor} = \frac{\text{Average demand}}{\text{Plant Capacity}}$$

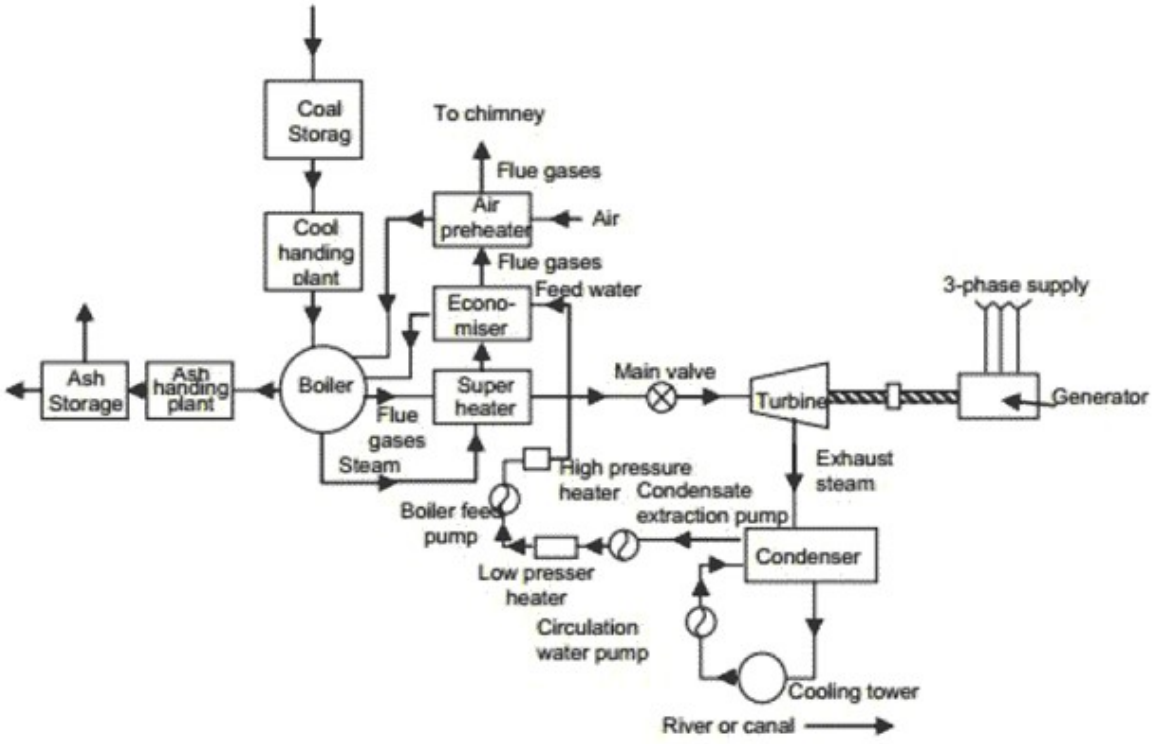
OR

$$\textbf{Plant capacity factor} = = \frac{\text{Actual energy generated}}{\text{Maximum possible energy (KWH) that could have been generated}}$$

e)	**Explain how load curves helps in the selection of size and number of generating units.**
Ans:	 or equivalent figure **Load curves helps in the selection of size and number of generating units as** **Following information is obtain from load curve:-** **(Any Four Point expected : 1 Mark each: Total 4 Marks)** 1. The variation of load on the plant during different hours of a day. 2. Load at any time during a day/month/year can be determined. 3. The area under the curve gives number of units generated daily/month/yearly 4. Maximum demand can be determining which largest peak value on the curve. 5. The maximum and minimum values of load during a day. 6. Average demand can be determine $$\text{Average demand} = \frac{\text{Number of unit generated}}{\text{Number of hours}}$$ 7. Load factor can be determine: $$\text{Load factor} = \frac{\text{Average Demand}}{\text{maximum demand}}$$ 8. The load curve helps in selecting the size and number of generating units. 9. Operation schedule of generating station can be determined. 10. It gives the indication whether the station is working efficiently or not.

Q.5	Attempt any TWO of the following 12 Marks
a)	**Explain with layout the working of typical thermal power plant with steam turbines and electric generators.**

Ans: **layout the working of typical thermal power plant with steam turbines and electric generators:** **(Layout: 3 Marks & Working : 3 Marks, Total 6 Marks)**

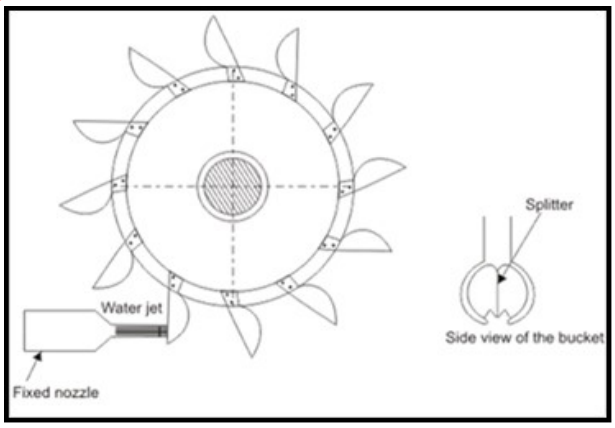


or Equivalent Figure

Working:-

In thermal power plants, the heat energy obtained from combustion of solid fuel (mostly coal) is used to convert water into steam, this steam is at high pressure and temperature. This steam is used to rotate the steam turbine. Shaft of turbine is connected to the generator. The generator converts the mechanical energy of the turbine into electric energy.

b)	**Explain with neat sketch the construction and working of pelton turbine used in hydro power plant.**
Ans:	**Diagram of Pelton Wheel:-** **(Diagram : 2 Marks, Construction : 2 Marks & Working : 2 Marks,Total 6 Marks)**



OR equivalent Sketch

Construction :
The various parts of the Pelton turbine are:

1. Nozzle and Flow Regulating Arrangement (Spear)

Nozzle is used to increase the kinetic energy of the water that is going to strike the buckets or vanes attached to the runner.

The quantity of water that strikes the buckets is controlled the spear. It is a conical needle present in the nozzle automatically in an axial direction.

When the spear is move backward the rate of flow of water increases and when it is pushed forward the rate of flow of water decreases.

2. Runner and Buckets

Runner is a rotating part of the turbine. It is a circular disc on the periphery of which a number of buckets evenly spaced are fixed.

The buckets are made by two hemispherical bowl joined together.

The buckets of the Pelton turbine are made up of cast iron, cast steel bronze or stainless steel.

3. Casing:

The outer covering of the turbine is called casing.

It prevents the splashing of the water. It protects the runner, runner buckets and other internal parts of the turbine from an external damage.It also acts as a safeguard in the case of any accident occurs. Cast iron or fabricated steel plates are used to make the casing of the Pelton Turbine.

4. Breaking jet:

In order to stop the runner in the shortest possible time a small nozzle is provided which directs the jet of water at the back of the vanes. This jet of water used to stop the runner of the turbine is called breaking jet.

Working of Pelton wheel:

The water stored at high head is made to flow through the penstock and reaches the nozzle of the Pelton turbine.

The nozzle increases the K.E. of the water and directs the water in the form of jet.

The jet of water from the nozzle strikes the buckets (vanes) of the runner. This made the runner to rotate at very high speed.

The quantity of water striking the vanes or buckets is controlled by the needle valve present inside the nozzle.

The generator is attached to the shaft of the runner which converts the mechanical energy of the runner into electrical energy.

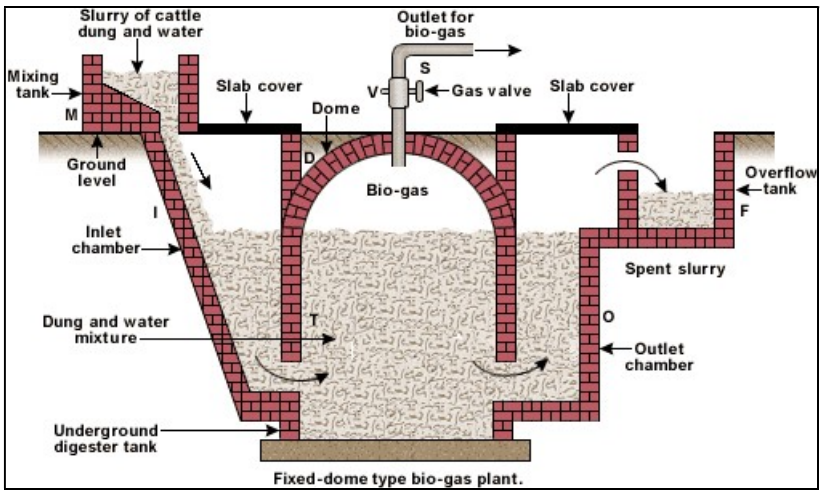
c)	**Explain with neat sketch, layout of Bio-chemical based (biogas) power plant.**
Ans:	**(Explanation : 3 Marks & Sketch Layout : 3 Marks, Total 6 Marks)**

Explanation:- **(3 Marks)**

In this process biomass fuel is converted to produces methane gas by pyrolysis or fermentation processes.

Which can be used to produce heat energy which is used to produce steam at high pressure and temperature. This steam is used to rotate the steam turbine. Shaft of turbine is connected to the generator. The generator converts the mechanical energy of the turbine into electric energy.

Layout of Bio-chemical based (biogas) power plant:- **(3 Marks)**



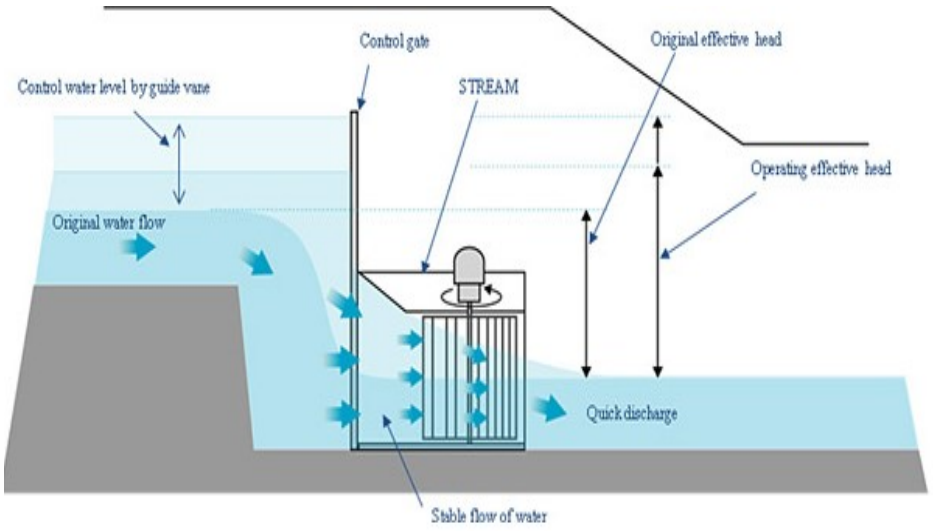
OR equivalent neat sketch layout

Q.6	**Attempt any TWO of the following** **12 Marks**
a)	**Draw the layout of typical micro hydro scheme and describe potential locations of micro-hydro power plants in Maharashtra.**

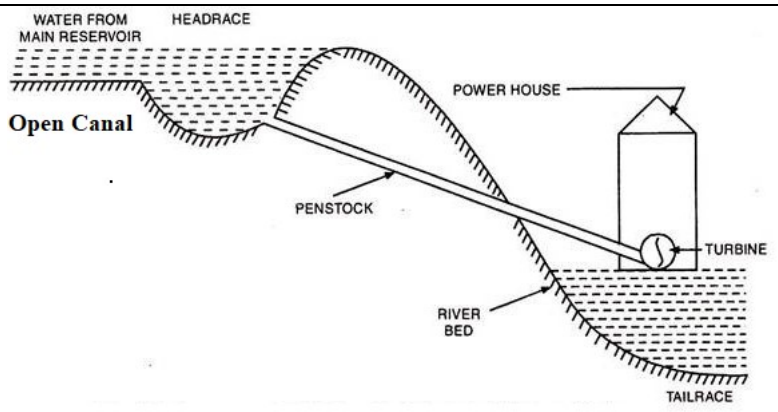
Ans:

Note:- Any equivalent layout should be considered
(Layout: 3 Marks, potential locations: 3 Marks, Total: 6 Marks)

Layout of typical micro hydro scheme: **(3 Marks)**



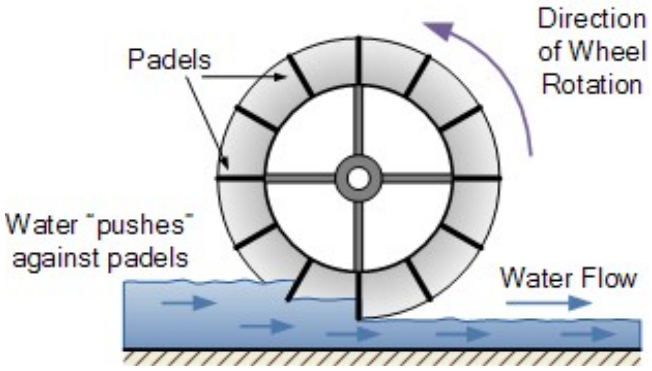
OR



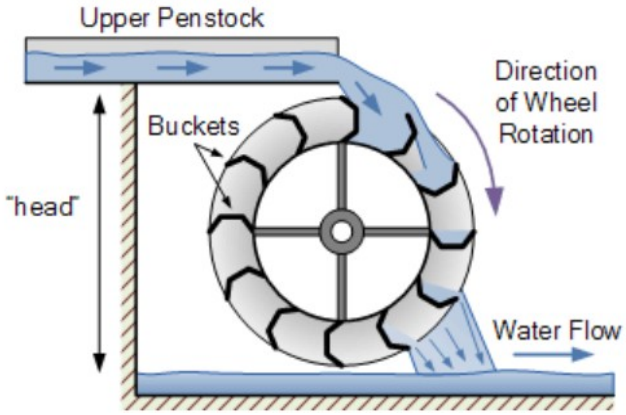
OR

Following types of Water Wheels (Gravity Turbines) are used to obtain mechanical power in case of Run of river scheme these water wheels are connected to generator to obtain electrical out put.

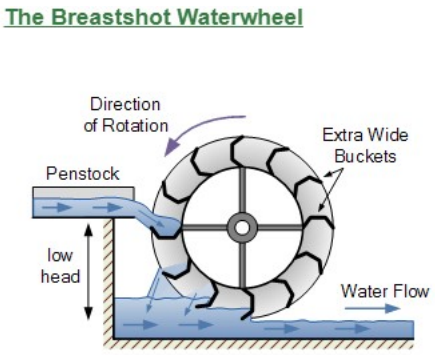
Undershot Water Wheel: -



Overshot Water Wheel: -



Breast shot water wheel:-



Potential locations of micro-hydro power plants in Maharashtra.

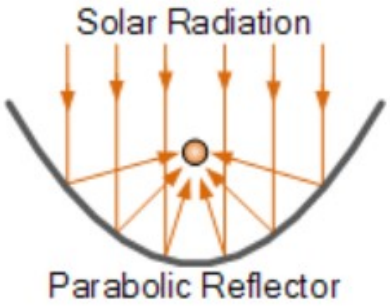
(Any three location are expected 1 Mark each Total 3 Marks)

Note :- Any location other than following are should be consider

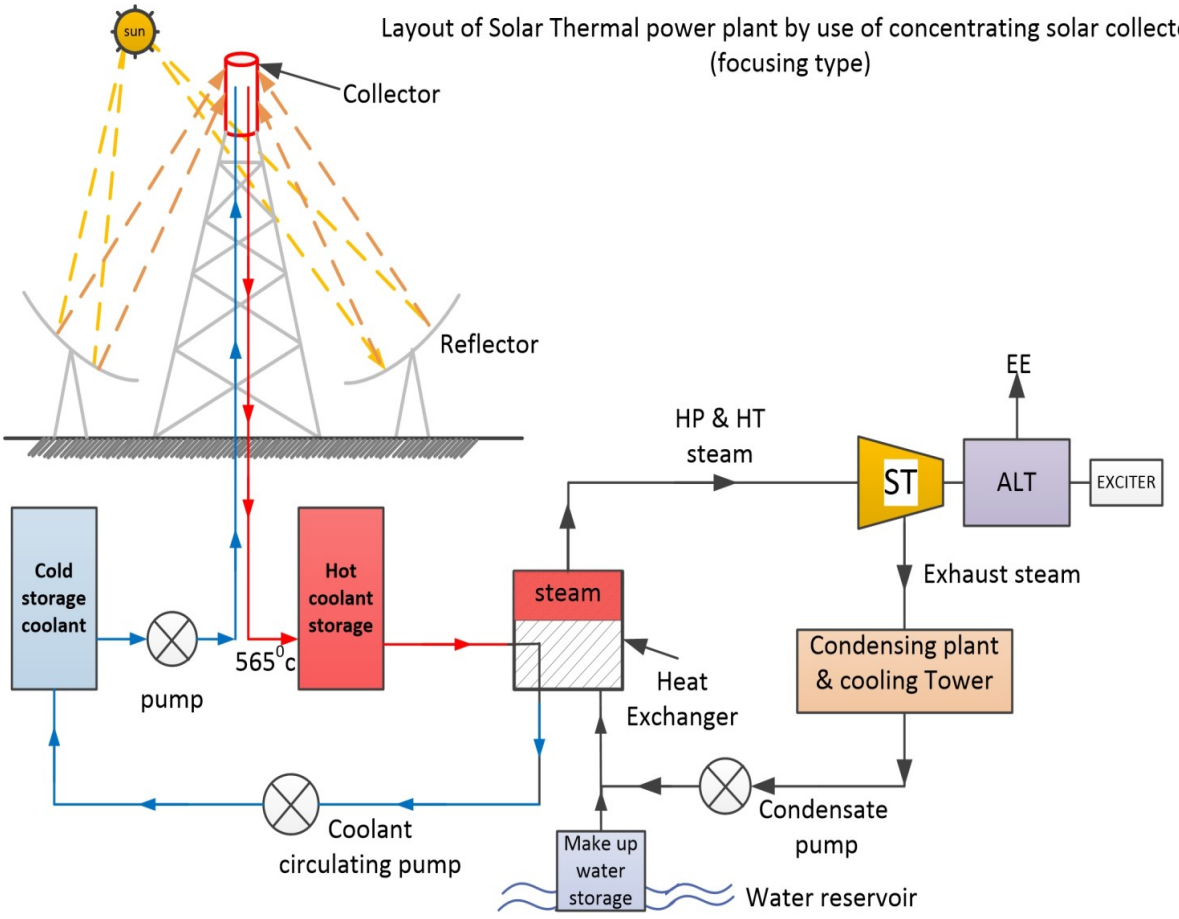
Sr.No.	Location name in Maharashtra
1	Terwanmedhe
2.	Ganagamshet project (Kolhapur)
2	Karwa project Nasik
3	Shenur project Amravati
4	Upper wardha project Amravati
5	Dham Project (Wardha)
6	Mukne Project (Nasik)
7	Khaner project (Satara)
8	Hetwane project (Raigad)
9	Kadwi project (Kolhapur)
10	Wan project (Akola)
11	Sasari project (Kolhapur)
12	Kumbhoi project (Kolhapur)
13	Patgaon project
14	Dom
15	Vaitarna D.T
16	Radhanagri
17	Manikodh
18	Dimbhe
19	Surya

b)	**Explain with layout, the working of parabolic trough collector concentrated solar power plants.**
Ans:	**(Explanation : 3 Marks, Layout : 3 Marks, Total : 6 Marks)**

layout of parabolic trough collector concentrated solar power plants : (3 Marks)



OR



OR equivalent Layout

- It consists of disc 6.6 meter in diameter has been made from mirrors formed in

to the shape parabola called as concentrator.

- Surface absorber (Receiver) which is well insulated which is located at focal point
  - The concentrator captures and reflect solar radiation towards receiver /collector (absorber)
  - The receiver absorbs the concentrated sunlight rays and gets heated.
- The disc can be turn automatically up-down and left-right, so that sun is always kept in a line. Thus the sun can be fully tracked.

OR

Working: **(3 Marks)**

- The concentrator captures and reflect solar radiation towards collector (absorber)
- The receiver absorbs the concentrated sunlight rays and gets heated.
- The secondary fuel (coolant or working fluid) is passed through collector.
- Transferring its heat energy to a working fluid.
- This coolant gets heated to a very high temperature.
- This hot coolant is stored in transport-storage system (a portion of the thermal energy is stored for later use).Thus solar energy can be used even when sun rays are not available
- Then hot coolant is passed through heat exchanger (steam generator) where steam at high temperature and high pressure is generated.
- This secondary fuel (coolant or working fluid) is re-circulated again and again.
- This steam at high temperature and high pressure is used to run the steam turbine.
- Steam turbine is coupled with alternator which converts mechanical power to electrical energy
- Exhaust steam is condensate in condenser.

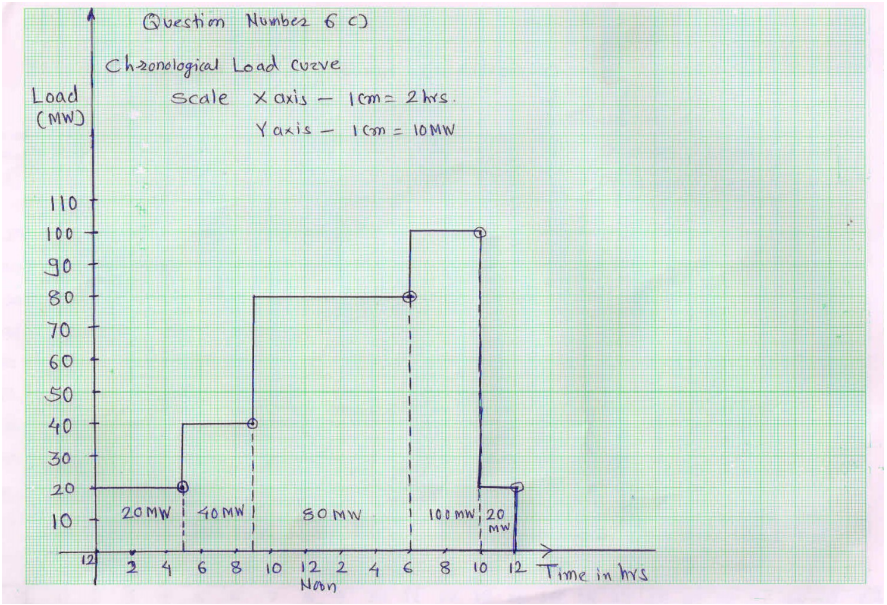
c) **A load on a power plant on a typical day is as under:-**

Time	12-5 AM	5-9 AM	9-6 PM	6-10 PM	10 PM-12 AM
Load in MW	20	40	80	100	20

Plot the chronological load curve and load duration curve. Find the load factor of the plant and energy supplied by the plant in 24 hours.

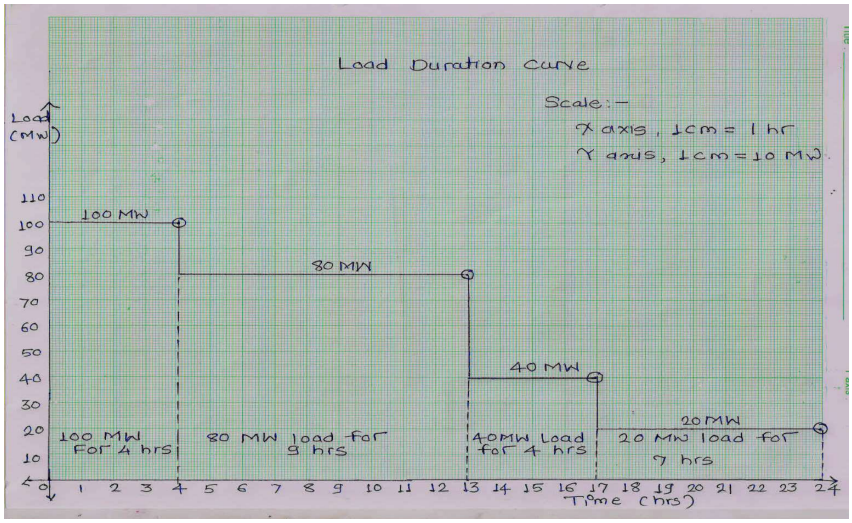
Ans: **Solutions:**

i) Chronological load curve: ---------- **(1 Mark)**



or equivalent graph

ii) load duration curve: ---------- **(1 Mark)**



or equivalent graph

i) It is clear from the load curve that maximum demand on the power station is **100 MW** and occurs during the period 6-10 PM

Maximum Demand: 100 MW ---------- **(1/2 Mark)**

ii) Energy supplied by the plant in 24 hours (Units generated /day) =

$= Area\,(in\ KWh)\ under\ the\ load\ curve$

$= 10^3\ (20\times 5 + 40\times 4 + 80\times 9 + 100\times 4 + 20\times 2)$

$= 10^3\ (100 + 160 + 720 + 400 + 40)\ kWh$

$= 1420\times 10^3\ KWh$ **OR** $= 1420\ MWh$ - ---------- **(1 Mark)**

iii)Average Load = ---------- **(1/2 Mark)**

$$= \frac{Units\ generated\ per\ day}{24\ hours} = \frac{1420\times 10^3}{24} = 59.1666\times 10^3\ KW$$

iv) Load Factor =

$$= \frac{Average\ load}{Maximum\ demand} = \frac{59.1666\times 10^3}{100\times 10^3}$$ ----------**(1Mark)**

= 0.591666 ---------- **(1 Mark)**

OR

$= 59.16\,\%$

----------END----------

22327

11920

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) List any two Thermal Power Station in Maharashtra with their installed capacity.

b) State any two applications of solar energy.

c) List out major wind farms in India.

d) Define State grid and National grid.

e) Name the main parts of solar power plant.

f) Classify hydro power plant on the basis of availability of water head.

g) List any two large hydro power plants in Maharashtra with their capacity.

Marks

2. Attempt any THREE of the following: **12**

a) Describe any four safe practices for Hydro Power Plants.

b) Draw a neat layout of typical Thermal power station and label it.

c) State the salient features of constant speed electric generator and variable speed electric generator.

d) List any four causes of faults on grid system.

3. Attempt any THREE of the following: **12**

a) Draw a block diagram of gas turbine power plant and lable each block.

b) Explain with sketch the layout and working of parabolic through concentrated Solar Power plant.

c) State any four factors for selection of hydro power plant.

d) Describe with sketch the layout and working of Geared wind power plant.

4. Attempt any THREE of the following: **12**

a) Explain the purpose of shielding and reflector in a nuclear reactor.

b) Explain with layout diagram; the construction and working of solar photo voltaic (PV) power plant.

c) Describe the layout and working of the horizontal and vertical axis small wind turbines.

d) Define :

(i) Max Demand

(ii) Average Demand

(iii) Plant capacity factor

(iv) Plant use factor

e) Compare base load and peak load power plants.

Marks

5. Attempt any TWO of the following: **12**

a) State the types of radioactive wastes generated in a nuclear power station. Explain the methods employed for their disposal.

b) State the functions of the following parts of hydroelectric power station:

(i) Reservoir

(ii) Tailrace

(iii) Spillway

(iv) Surgetank

(v) Forebay

(vi) Turbine

c) Explain with sketch; the layout of a thermo chemical based (municipal waste) power plant.

6. Attempt any TWO of the following: **12**

a) Explain with sketches the construction and working of the Pelton turbine used for high head power plant.

b) Describe the features of solid, liquid and gas biomasses as fuel for biomass power plant.

c) The peak load on a power station is 30 MW. The loads having maximum demands of 25 MW, 10 MW, 5 MW and 7 MW are connected to the power station. Capacity of the power station is 40 MW and annual load factor is 50%. Find:

(i) Average load on power station

(ii) Energy supplied per year

(iii) Demand factor

(iv) Diversity factor

Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

.1	**Attempt any FIVE of the following**	**10 Marks**
a)	**List any two Thermal Power Station in Maharashtra with their installed capacity.**	

Ans: **(Any Two power plant name expected or any equivalent: 1 Mark each, Total 2 Mark)**

Sr.No.	Name of Thermal Power Plant	Plant Capacity
1	Koradi	1100 MW
2	Nashik	910 MW
3	Chandrapur	2340 MW
4	Parali	1130 MW
5	Bhusawal	920 MW
6	Paras	500 MW
7	Khaparkheda	1340 MW
8	TATA (Trombay)	1400 MW
9	Dhahanu (Thane)	500 MW
10	Wardha	135 MW
11	Amravati	2700 MW
12	Jindal (Ratnagiri)	1200 MW

b)	**State any two applications of solar energy.**
Ans:	**Solar energy can be used directly or indirectly for following applications or any equivalent:** **(Any Two applications expected: 1 Mark each, Total 2 Marks)** 1. For street lighting. 2. For road Traffic, signaling system. 3. For railway Traffic signaling system. 4. For lifting water with the help of solar pumps. 5. In satellite solar energy is used. 6. In weather monitoring System. 7. Lighting in remote place area.(Off grid) 8. Solar cells are used in watches and calculator. 9. Solar mobile charger. 10. For radio and Television set. 11. Solar blinker and road divider. 12. Solar mini cars are under development. 13. Solar cooker. 14. Solar water heater. 15. Solar dryer for crops. 16. Solar furnace 17. Solar distillation 18. Space heating of building
c)	**List out major wind farms in India.**
Ans:	**Major wind farms in India or any equivalent:** **(Any Two wind farms expected: 1 Mark each, Total 2 Marks)**

S.No	**Major wind farms in India**
1	Dhalgaon Wind farm of Sangli, Maharashtra,

2	Vankusawade Wind Park in Satara, Maharashtra,
3	Vaspet Wind farm of Maharashtra,
4	Brahmanvel Wind Farm Dhule, Maharashtra
5	Tuppadahalli Wind Farm, Chitradurga , Karnataka
6	Beluguppa Wind Park in Andhra Pradesh.
7	Anantapur Wind Park in Andhra Pradesh.
8	Muppandal Wind farm Kanyakumari, Tamil Nadu
9	Jaisalmer Wind Park, Rajasthan
10	Damanjodi Wind Farm, Odisha

d) Define State grid and National grid.

Ans:

i) State Grid System: **(1 Marks)**

When all the major generating stations in state are interconnected to each other through transmission line, it forms a state grid system

ii) National Grid System: **(1 Marks)**

All state grids are interconnected to each other through transmission line; it forms a national grid system

e) Name the main parts of solar power plant.

Ans:

Main parts of solar power plant:- **(2 Marks)**

1. Solar panel (PV cell panel)
2. Charge controller
3. Storage battery
4. Inverter
5. Step up transformer

OR Student may write

Main parts of solar power plant. **(2 Marks)**

1. Concentrator
2. Receiver
3. Transport-storage (a portion of the thermal energy is stored for later use)
4. Steam generator (Heat exchanger)
5. Condenser
6. Steam turbine
7. Alternator

f) Classify hydro power plant on the basis of availability of water head.

Ans: **Classification the hydro-electric plants According to availability of Head of Water:**

(2 Mark)

1. Very high head power plant
2. High head power plant
3. Medium head power plant
4. Low head power plant

OR

1. High head power plant
2. Medium head power plant
3. Low head power plant

g) List any two large hydro power plants in Maharashtra with their capacity.

Ans: **Hydro-electric power stations in Maharashtra or equivalent:-**

(Any Two plants expected : 1 Mark each, Total : 2 Marks)

	List of large hydro power plants in Maharashtra	
S.No	**Location**	**Capacity**
1	Koyana	1960MW
2	Ghatghar Dam	250MW
3	Bhira (TATA)	150 MW
4	Mulshi Dam	150MW
	Student may write following location	
5	Bhira Tail Race	80 MW

6	Bhivapuri (TATA)	72 MW
7	Khopoli (TATA)	72 MW
8	Tillari	60 MW
9	Pench project	53 MW
10	Bhandara	34 MW
11	Dudhgaon	24 MW
12	Chadholi(Warana)	16MW
13	Jayakwadi	12 MW
14	Paithon/Ujjani	12 MW
15	Veer	9 MW
16	Bhatghar	16 MW
17	Vaitarana Dam	1.5 MW
18	Eldary	22.5 MW
19	Radhanagri	4.8 MW
20	Paitan	12 MW
21	Pawan	10 MW
22	Panshet	8 MW
23	Varasgoan	8 MW
24	Kanher	4 MW
25	Bhatsa	15 MW
26	Dhom	2 MW
27	Manikdoh	6 MW
28	Yeoteshwar	0.075 MW
29	Dimbhe	5 MW

Q. 2 **Attempt any THREE of the following** **12 Marks**

a) **Describe any four safe practices for Hydro Power Plants.**

Ans: **Following are the safe practices:-**

(Any four point expected: 1 Mark each, Total : 4 Marks)

1. The Personal Protective Equipment (PPE) / protective devices made available for individual or collective use of the workers likely to be affected by the hazards of the workplace or process.
2. Not to allow any worker to work in an unsafe condition, nor with unsafe equipment

3. Sufficient number of Supervisors shall be appointed for adequate and constant supervision at all times and in all workplaces
4. All workers are protected from the hazards, arising out of their work or due to the work carried out by others, in the vicinity
5. Safety training shall be provided to all employs Appoint a Safety Officers with the qualifications and experience
6. Safety posters, slogan competition, special meetings and talks shall be organized.
7. Emergency action plan should be ready to deal with fire and explosion
8. Power plant should be protected against lightning stroke i.e. use appropriate type of lightning arrestor.
9. Barricades, warning sign, safety posters should be provided to hazards and important locations
10. Station should have at least two independent ways to exit. If one route becomes inaccessible, an alternative emergency escape route should always be available. Adequate lighting is essential for emergency escapes.
11. During flood there should be provision of automatically stop the hydro plant.
12. Plant should be inspected from OSHA and NFPA organization

OR

Following are the different protection provided to HPP for safety:-

1. Fore bay:-

It serves the following function is-

- It store rejected water immediately when load on turbine reduces so it avoid water hammer effect in penstock and protect the penstock.
- It avoids cavity effect in penstock when load on turbine increases (Because it immediately supplies the water).
- It acts as buffer storage of water during flooding which increases the safety of dam.

2. Trash rack (Screen/ Booms):-

- It avoids entry of debris (solid particles, large fish, and ice) going towards the turbine.
- It avoids choke up of penstock and damage to turbine.

3. Spillways: -

- It discharge excess water from reservoir when the water exceeds the storage capacity of reservoir.
- It avoids damage to dam due to excess pressure of water.
- It acts as a safety valve to the dam.

4. **Protection provided to penstock**:

- Surge Tank or fore bay
- Automatic butterfly valve
- Air valve

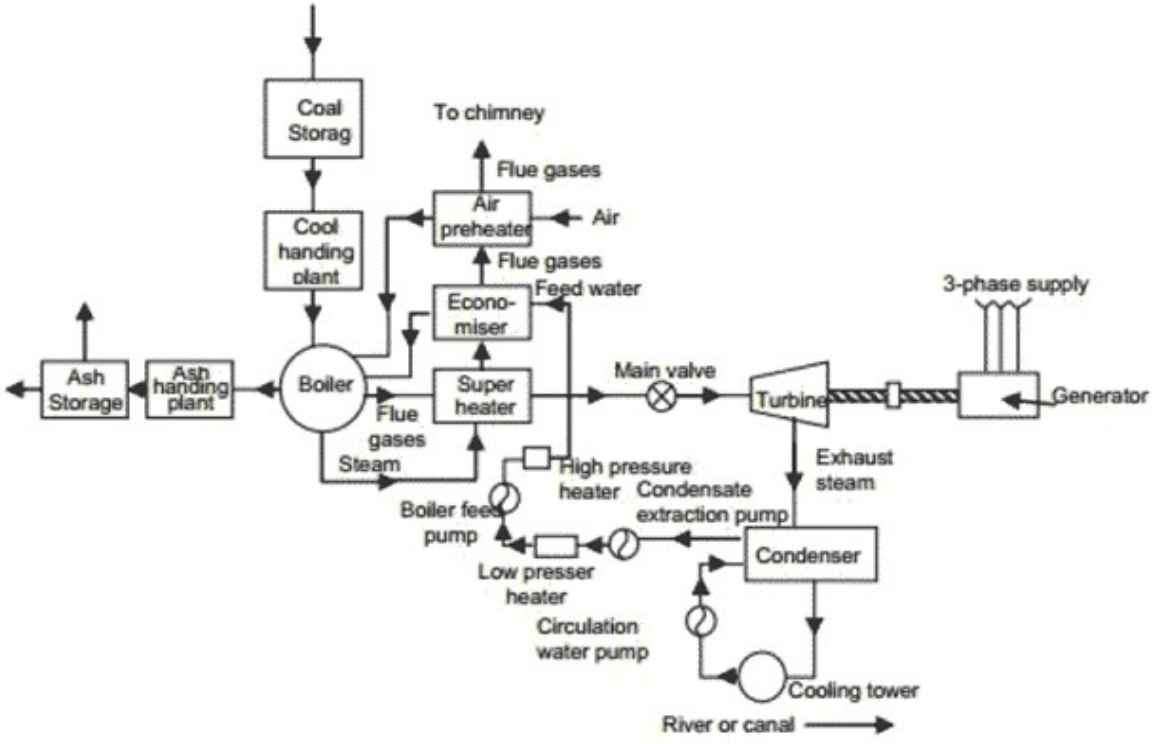
5. **Surge tank:-**

- It protects penstock from water hammer effect when load on turbine reduces (Because it immediately stores the rejected water).
- It avoids cavity effect in penstock when load on turbine increases (Because it immediately supplies the water).

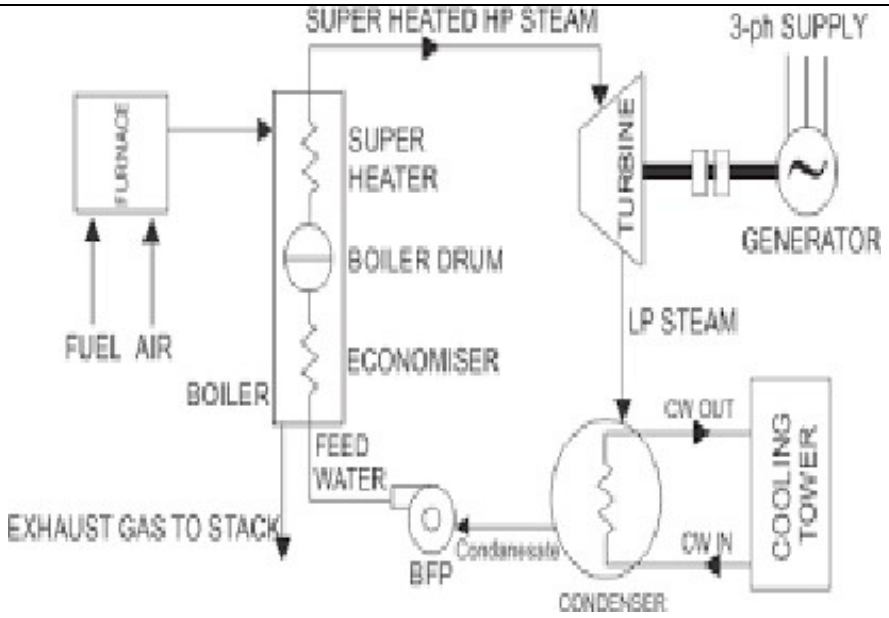
b) Draw a neat layout of typical Thermal power station and label it.

Ans:

Neat layout of typical Thermal power station : **(4 Marks)**



OR equivalent figure



OR equivalent figure

c) State the salient features of constant speed electric generator and variable speed electric generator.

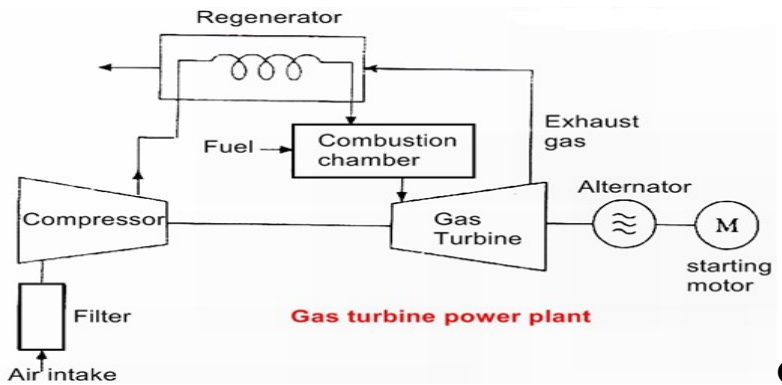
Ans:

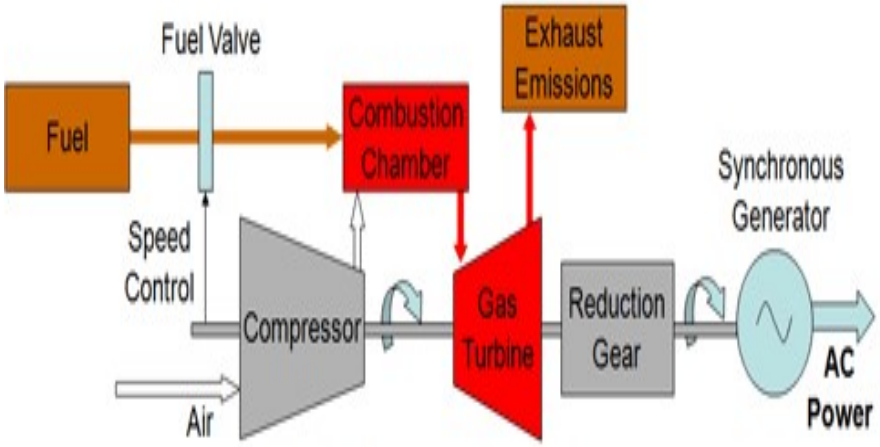
Following are salient features of constant speed electric generator: **(2 Marks)**

1. Less energy capture from wind.
2. Mechanical stresses on wind turbine are more.
3. Pitch controller mechanism is required.
4. These systems have a multiple-stage gearbox so size and weight is more.
5. The power converters not required.
6. Harmonics not present in output voltage.

Following are salient features of variable speed electric generator: **(2 Marks)**

1. More energy capture from wind.
2. Mechanical stresses on wind turbine are less.
3. Noise produced is less.
4. Pitch controller mechanism is not required.
5. This systems is not required multiple-stage gearbox so size and weight is less.
6. The power converters are required.
7. Harmonics are present in output voltage.

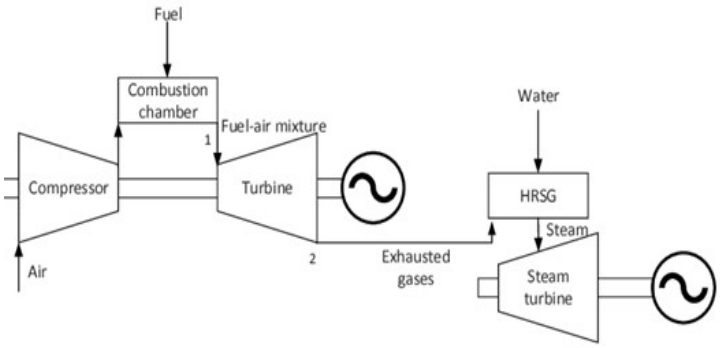
d)	**List any four causes of faults on grid system.**
Ans:	**Following are the causes of faults on grid system or equivalent:** **(Any FOUR Point expected : 1 Mark each point, Total 4 Marks)** 1. Major imbalance between generation and consumption. 2. Low frequency, due to some faults the frequency mismatches then, there is possibility of failure of power grid. 3. Due to breaking of conductor or due to short circuit between two conductors fault occurs which leads to failure of grid. 4. Power surges causes rapid overheating tends to lead failure of grid. 5. Minor fault in high voltage equipment's if not attended over a period of time results in a total breakdown of equipment suddenly causing grid failure. 6. Illegal utilization of electricity (theft of energy) is also a major reason for power grid failure. 7. Ageing of power equipment's have higher failure rates increases the risk of frequent breakdown. 8. Due to failure of grid connected one of the generator units suddenly. Then load is shifted to other generator causes cascade tripping due to over loading. 9. Due to ineffective power delivery planning, co-ordination, supervision and control over generation system causes failure of grid (Due to ineffective work of LDC).
Q.3	**Attempt any THREE of the following** **12 Marks**
a)	**Draw a block diagram of gas turbine power plant and label each block.**
Ans:	**Block diagram of gas turbine power plant:-** **(4 Marks)**  **OR Equivalent Figure**



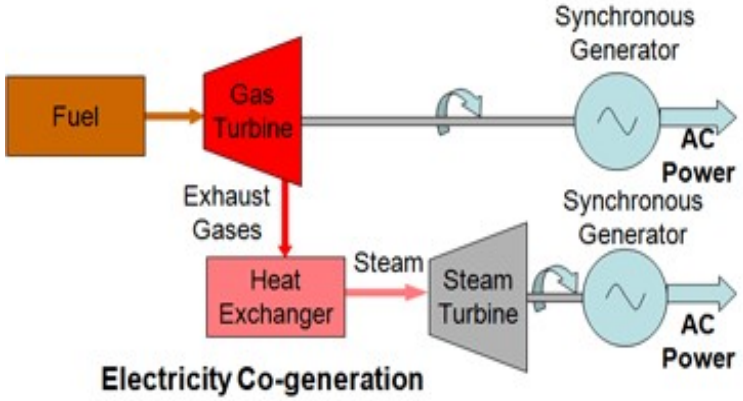
Gas Turbine Electric Power Generation

OR Equivalent Figure

Schematic arrangement for a gas power plant Combined Cycle Systems :-

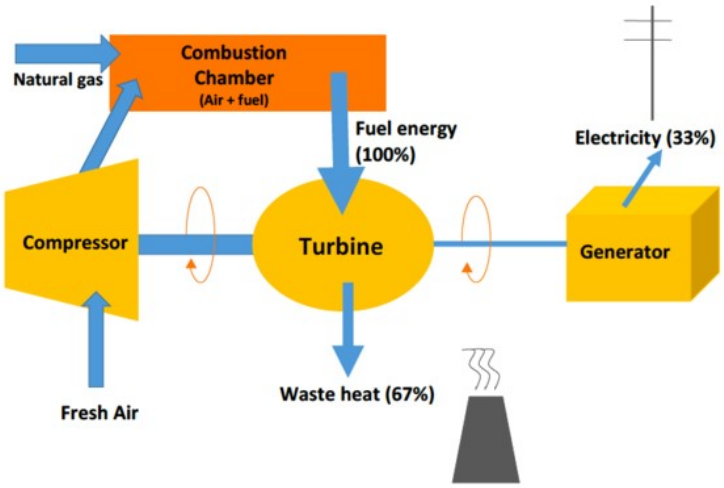


OR Equivalent Figure



Electricity Co-generation

OR

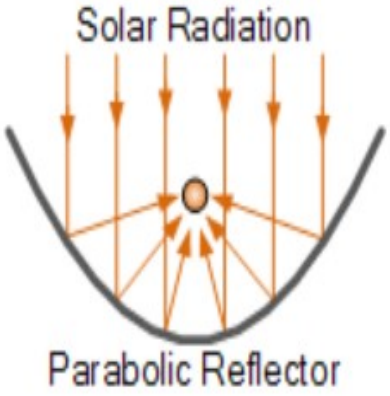


OR Equivalent Figure

b) Explain with sketch the layout and working of parabolic through concentrated Solar Power plant.

Ans: **(Explanation : 2 Marks, Layout : 2 Marks, Total : 4 Marks)**

layout of parabolic trough collector concentrated solar power plants : (2 Marks)



OR equivalent figure

Working: (2 Marks)

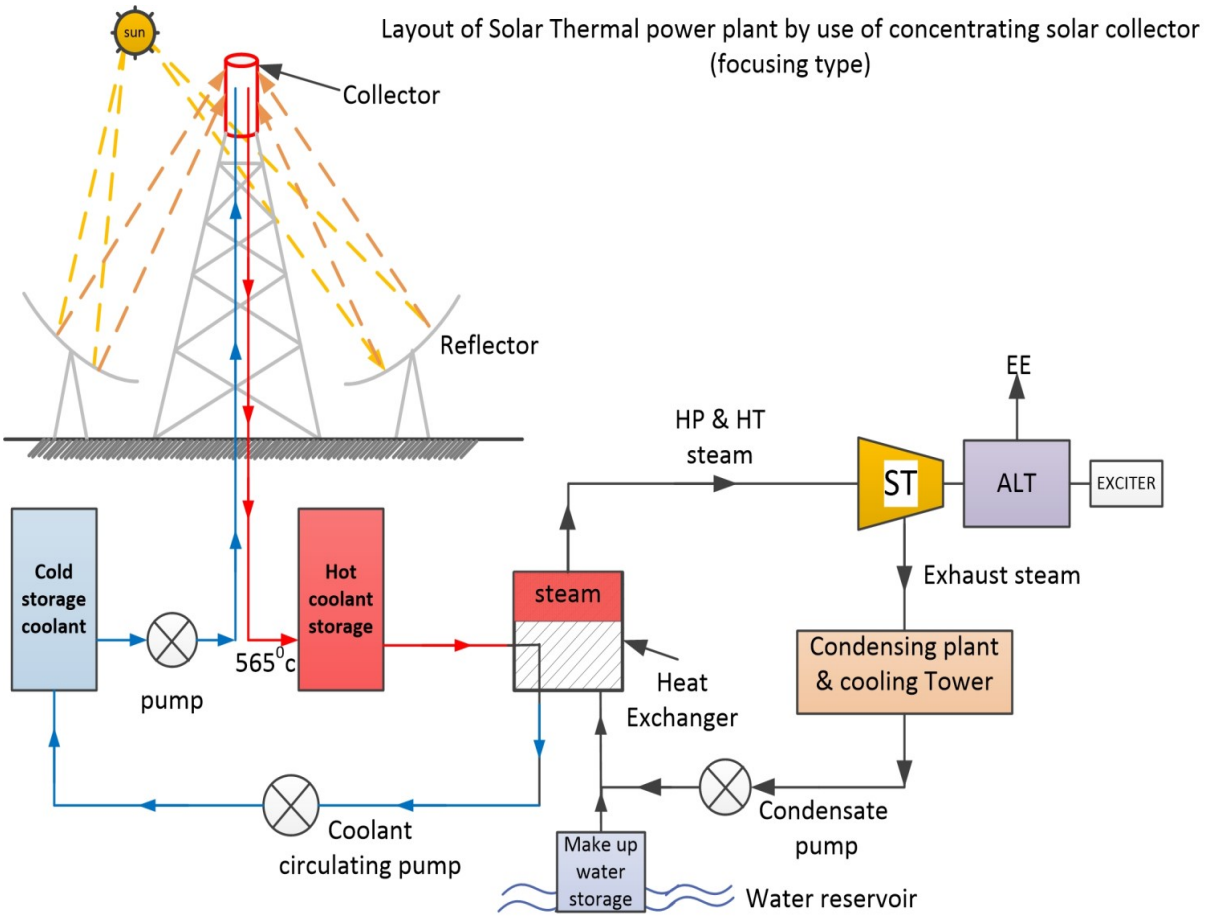
- It consists of disc 6.6 meter in diameter has been made from mirrors formed in to the shape parabola called as concentrator.
- Surface absorber (Receiver) which is well insulated which is located at focal point
- The concentrator captures and reflect solar radiation towards receiver

/collector (absorber)

- The receiver absorbs the concentrated sunlight rays and gets heated.
- The disc can be turn automatically up-down and left-right, so that sun is always kept in a line. Thus the sun can be fully tracked.

OR

layout of parabolic trough collector concentrated solar power plants : **(2 Marks)**



OR equivalent Layout

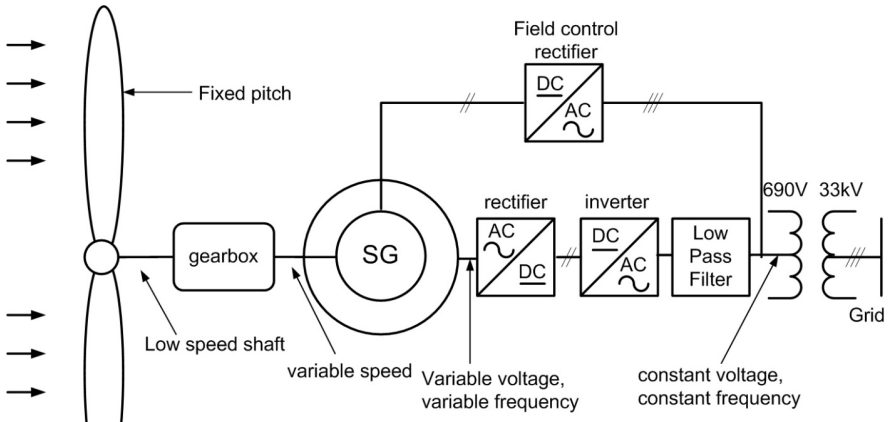
Working: **(2 Marks)**

- The concentrator captures and reflect solar radiation towards collector (absorber)
- The receiver absorbs the concentrated sunlight rays and gets heated.

	➢ The secondary fuel (coolant or working fluid) is passed through collector. ➢ Transferring its heat energy to a working fluid. ➢ This coolant gets heated to a very high temperature. ➢ This hot coolant is stored in transport-storage system (a portion of the thermal energy is stored for later use).Thus solar energy can be used even when sun rays are not available ➢ Then hot coolant is passed through heat exchanger (steam generator) where steam at high temperature and high pressure is generated. ➢ This secondary fuel (coolant or working fluid) is re-circulated again and again. ➢ This steam at high temperature and high pressure is used to run the steam turbine. ➢ Steam turbine is coupled with alternator which converts mechanical power to electrical energy ➢ Exhaust steam is condensate in condenser.
c)	**State any four factors for selection of hydro power plant.**
Ans:	**Following Factors to be kept while site selecting for Hydro power plant:** **(Any FOUR Point Expected : 1 Mark each Point, Total 4 Marks)** 1. It should be located where high rain fall occurs. 2. A large catchments area must be available to store water. 3. It should be located as far as possible in hilly area to reduce construction cost of dam and water reservoir. 4. Stored water should have a reasonable head (Potential Energy). 5. There should be easy access towards the site. 6. Land should have high bearing capacity to reduce the construction cost of dam and for better foundation of machinery. 7. Power plant should be located as far as possible near load center to reduce transmission line cost and losses in it. 8. During the construction of dam, it should be possible to divert the stream of river. 9. The Area should be free from earthquake and natural hazards. 10. It is necessary to see that water is of good quality (i.e.no chemical impurities) because polluted water may cause corrosion.

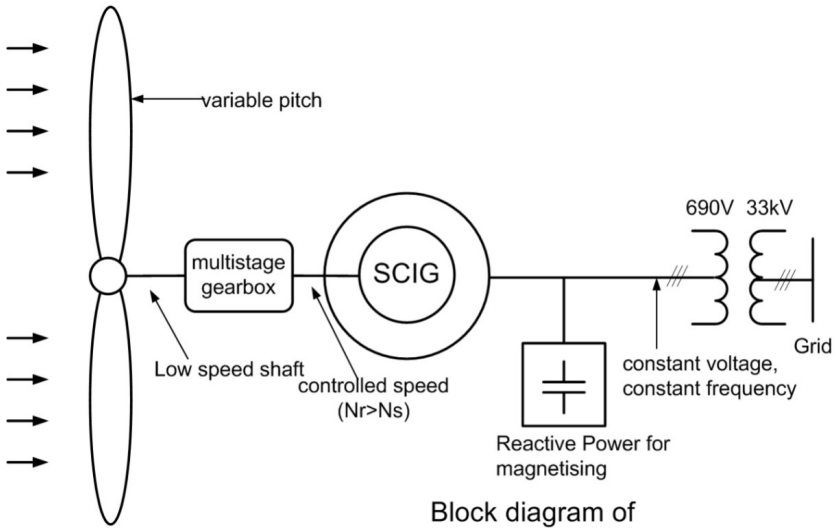
	11. The catchment area should be such that there are less accumulation of slit and debris (Solid Impurities). 12. Cost of land should be less. 13. Skilled and unskilled man power should be available nearby.
d)	**Describe with sketch the layout and working of Geared wind power plant.**
Ans:	**(Any one following figure or equivalent figure may be consider 3 Marks for fig., 1 Mark for explanation, Total 4 Marks)**

OR



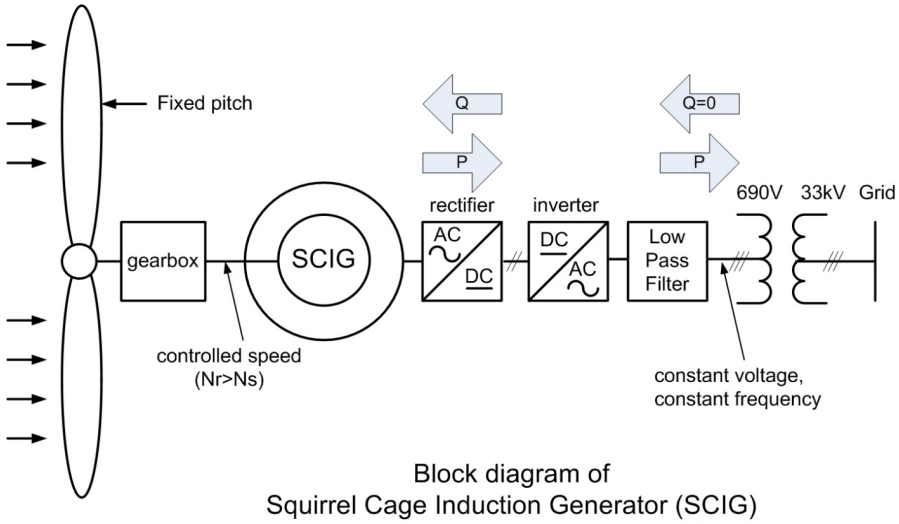
Block diagram of
Wound Rotor Synchronous Generator (WRSG) Wind power plant
(variable speed)

OR



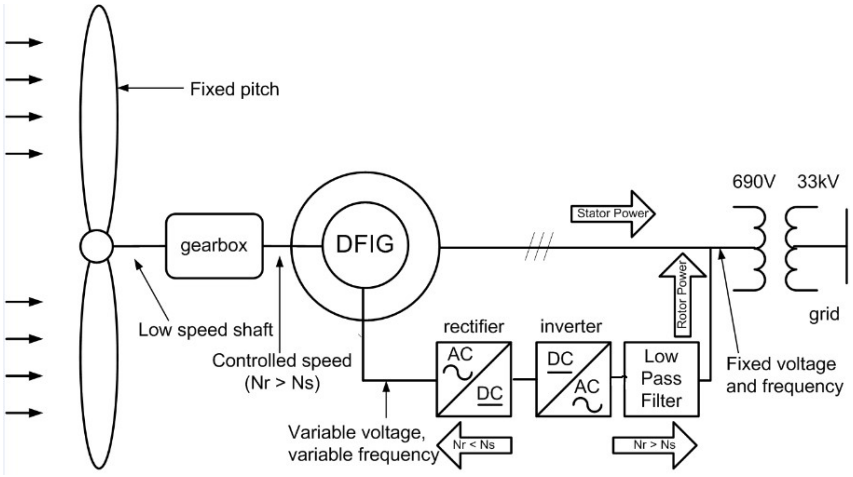
Block diagram of
Squirrel Cage Induction Generator (SCIG) Wind power plant
(constant speed)

OR



Block diagram of
Squirrel Cage Induction Generator (SCIG)
Wind power plant (variable speed)

OR



Explanation:-

Variable speed wind geared wind power plant:-

Because the actual wind speeds are variable, the generator cannot generate electrical power with fixed voltage and frequency magnitude. As a result, they should be connected to the power grid through AC-DC-AC conversion by power converters. That is, the generated AC power (with variable frequency and magnitude) is first rectified into fixed DC and then converted back into AC power (with fixed frequency and magnitude).

Constant speed wind geared wind power plant:-

A gearbox is typically used in a wind turbine to increase rotational speed from a low-speed rotor to a higher speed electrical generator. A common ratio is about 90:1, with a rate 16.7 rpm input from the rotor to 1,500 rpm output for the generator.

Q.4	**Attempt any THREE of the following**	**12 Marks**

a) Explain the purpose of shielding and reflector in a nuclear reactor.

Ans:

Purpose of shielding in Nuclear Power Plant: **(2 Marks)**

Shielding is provided to absorb alpha, beta particles and gama rays which are produced during nuclear chain reaction (fission process)

The function of shielding is to protect environment, humans and animals from the harmful radioactive radiation pollution before they are emitted to atmosphere.

Purpose of reflector in a nuclear reactor: **(2 Marks)**

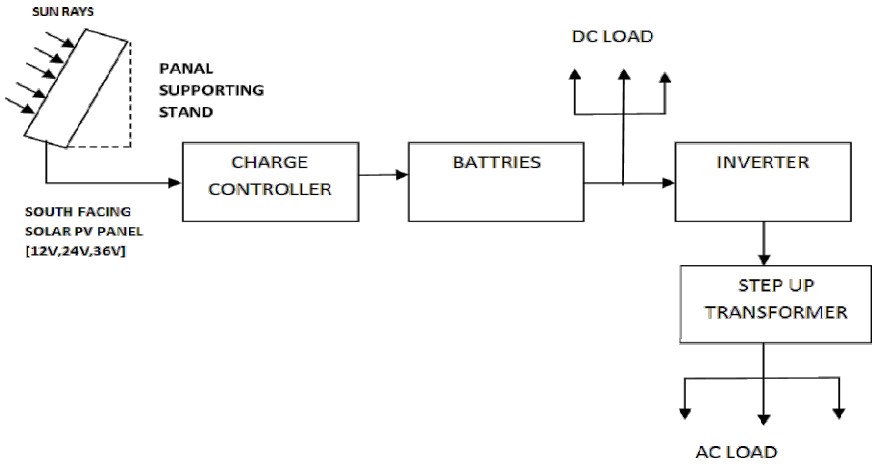
- The function of reflector is to reflect back the neutrons which are leaving from the core.

b) Explain with layout diagram; the construction and working of solar photo voltaic (PV) power plant.

Ans:

Diagram of solar photovoltaic power plant :

(Layout : 2 Marks & working : 2 Marks, Total : 4 Marks)



OR Equivalent Figure

Working:-

1. Photovoltaic cell panel:

Its function is to convert sunrays directly into DC electricity.

2.Battery charge Controller:

It protects battery from over charging and it prevents battery from over discharging. In this way it increases life of storage battery. (OR a charge controller is needed to ensure the battery is neither over nor under-charged)

3.Storage Battery:

Its function is store DC electrical energy generated by P.V. cell which can be used whenever required.

4.Inverter:

It converts DC supply into AC supply.

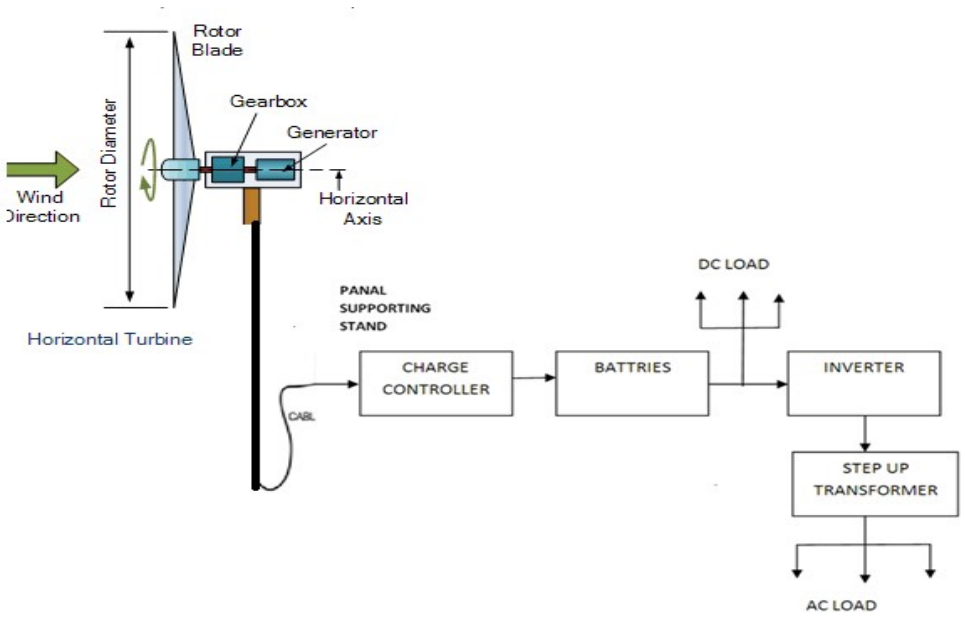
5. Step-up transformer:

It step-up input voltage to utilization voltage e.g. 230V

c) Describe the layout and working of the horizontal and vertical axis small wind turbines.

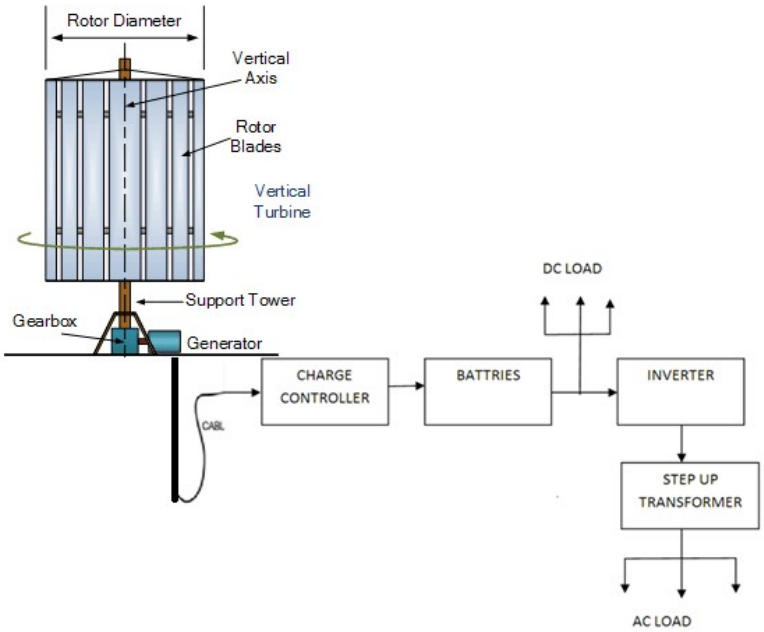
Ans: **(Following figure or equivalent figure may be consider 3 Marks for fig., 1 Mark for explanation, Total 4 Marks)**

i) Diagram of Horizontal axis wind turbine



or equivalent figure

ii) Diagram of Vertical axis wind turbine



or equivalent figure

Explanation:-

1. **Horizontal axis wind turbine :-** Axis of rotation is parallel to the ground

   Vertical axis wind turbine:- Axis of rotation is perpendicular to ground

2. Battery charge Controller:

It protects battery from over charging in this way itincreases life of storage battery.

3. Storage Battery:

Its function is store DC electrical energy generated by P.V. cell which can be used whenever required.

Generally battery having long life are used There are two types of battery:

1. Lead acidic battery
2. Nickel cadmium battery

4. Inverter:

It convert DC supply into AC supply..

5. Step-up transformer:

It step-up input voltage to utilization voltage e.g. 230V

d)	**Define : (i) Max Demand (ii) Average Demand (iii) Plant capacity factor (iv) Plant use factor**

Ans:

(Each definition 1 mark ,Total 4 Marks)

i) Maximum Demand: **(1 Mark)**

It is the maximum load which a consumer uses at a particular time period out of his total connected load.

ii) Average Demand :- **(1 Mark)**

$$\text{Daily Average Demand} = \frac{\text{Number of units generated (KWH) in one day}}{\text{Number of hours in a day (24 hours)}}$$

OR

$$\text{Monthly Average Demand} = \frac{\textit{Number of units generated (KWH) in month}}{\textit{Number of hours in a month}}$$

OR

$$\text{Yearly Average Demand} = \frac{\text{Number of units generated (KWH) in one Year}}{\text{Number of hours in one year}}$$

iii) Plant capacity factor: **(1 Mark)**

"The net capacity factor of a power plant is the ratio of its actual output over a period of time, to its potential output if it were possible for it to operate at full nameplate capacity indefinitely.

OR

It is the ratio of actual energy produced (generated) to the maximum possible energy that could have been produced (generated) during a given period.

OR

$$\text{Plant Capacity Factor} = \frac{\text{Energy that is produced}}{\text{Maxium energy that can be produced}}$$

$$\text{Plant Capacity Factor} = \frac{\text{Average demand}}{\text{Plant Capacity}}$$

OR

Plant capacity factor = $= \frac{\text{Actual energy generated}}{\text{Maximum possible energy (KWH) that could have been generated}}$

iv) Plant use Factor:- **(1 Mark)**

The definition such that the ratio becomes the amount of energy **used** divided by the maximum possible to be **used**.

It is the ratio of number of unit (kWh) generated to the product of plant capacity and the number of hours for which plant was in operation.

OR

$$i.e\ plant\ use\ factor = \frac{Station\ output\ in\ kWh}{Plant\ capacity \times hours\ of\ use}$$

e) Compare base load and peak load power plants.

Ans: **(Any Four Point expected : 1 Mark each point, Total 4 Marks)**

Sr.No.	Points	Base load plant	Peak load plant
1	Definition	The power plant which supplies base load of load curve is known as base load plant	The power plant which supplies peak load of load curve is known as peak load plant
2	Generating capacity	High	Low
3	Firm capacity	High	Low
4	Working Hours	24 hours	Only during peak load hours
5	Starting time	Both quick & more starting time power plant can be selected as a base load plant	Quick starting time power plant are selected as a peak load plant
6	Load factor	High	Low
7	Capacity Factor	High	Low
8	Plant use factor	High	Low
9	Examples	Large capacity hydro, thermal, nuclear power station	Small capacity storage hydro, pumped storage hydro, gas, diesel power station.

Q.5	Attempt any TWO of the following	12 Marks
a)	**State the types of radioactive wastes generated in a nuclear power station. Explain the methods employed for their disposal.**	

Ans:

➢ **Types of radioactive waste**:

The waste produced in nuclear power plant is in the form of :-

1. Solid Waste
2. Liquid Waste
3. Gases Waste

1. Solid Waste Disposal:- **(2 Marks)**

- Solid wastes removed from the reactor are very hot and radioactive.
- Solid waste is filled in a sealed container.
- And is kept under water for 5 to 10 years under supervision to reduces its temperature.
- The solid waste container is buried deeply in the ground by making tunnel, however the area must be unused land, away from populated area and there is less rain fall in that area.

OR

- Solid waste is filled in a sealed container and is disposed off away from sea shore.

OR

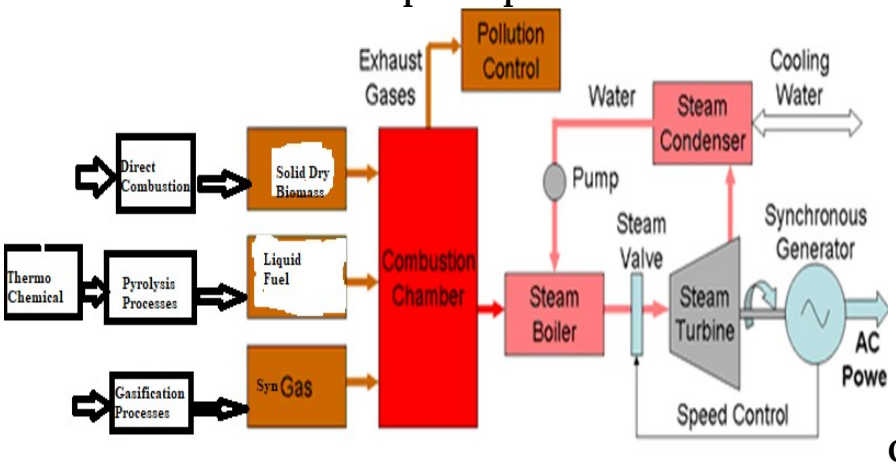
- Many times old and unused coal mines, salt mines, can be used for waste disposal

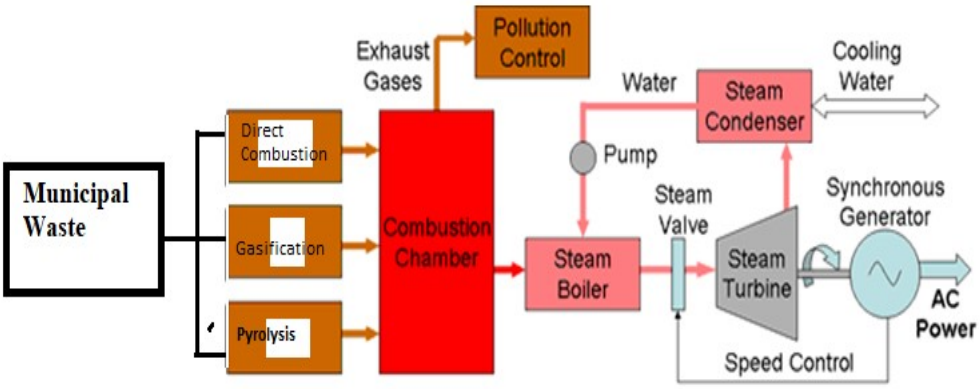
2. Liquid Waste Disposal:- **(2 Marks)**

- The liquid waste is diluted to a sufficient level by adding large quantity of water.
- The liquid waste after analysis (concentration of radioactive material are measured.) is sealed in a container.
- Then it is disposal off into the sea several kilometers away from sea shore.

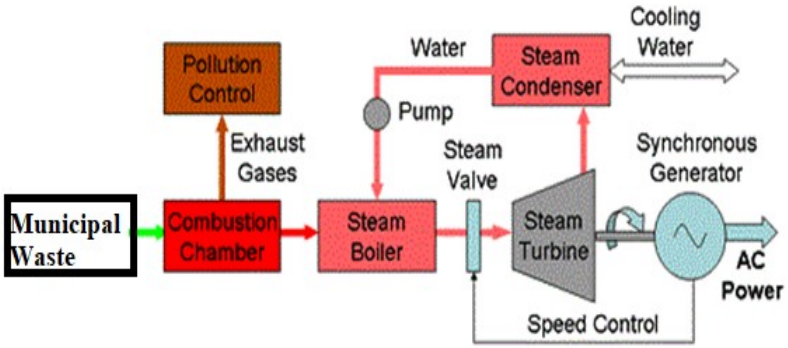
3. Gaseous Waste Disposal:- **(2 Marks)**

- Gaseous wastes are generally diluted with adding air.
- And passed through high efficiency filter.
- Then passed through radiation monitoring system.
- In this system concentration of radioactive material are measured.
- If it is safe then released to atmosphere at high level through large height chimney.

b)	**State the functions of the following parts of hydroelectric power station: (i) Reservoir (ii) Tailrace (iii) Spillway (iv) Surge tank (v) Forebay (vi) Turbine**
Ans:	**(Each definition : 1 Mark each, Total 6 Marks)** **(i) Function of Reservoir:-** **(1 Marks)** Its function is to store the water during rainy season and supplies the same throughout the year. **ii) Function Tail race:-** **(1 Marks)** To carry the water leaving from turbine. **iii) Spillways: -** **(1 Marks)** ➢ Its function is to discharge excess water from reservoir when the water exceeds the storage capacity of reservoir. ➢ It avoids damage to dam due to excess pressure of water. ➢ It acts as a safety valve to the dam. **iv) Surge Tank:-** **(1 Marks)** ➢ It protects penstock from water hammer effect when load on turbine reduces. ➢ It avoids cavity effect in penstock when load on turbine increases. **v) Fore bay:-** **(1 Marks)** ➢ Fore bay stores more quantity of water at intake. ➢ It performs the function of surge tank for small and medium head power plant. **vi) Turbine:** **(1 Marks)** It function is to convert kinetic energy of water into mechanical energy.
c)	**Explain with sketch; the layout of a thermo chemical based (municipal waste) power plant.**
Ans:	**(Explain 3 Marks and layout 3 Marks, Total 6 Marks)** **Layout of a thermo-chemical based power plant:** **(3 Marks)**  **OR**



OR Equivalent Figure



Explanation of Thermo chemical based (municipal waste PP):- **(3 Marks)**

In this process dry municipal waste (biomass fuels) is converted to produce gas, liquid fuels or oil by thermo chemical conversion Thermo-Chemical conversion are of following ways:-

1. Direct combustion
2. Gasification
3. Pyrolysis

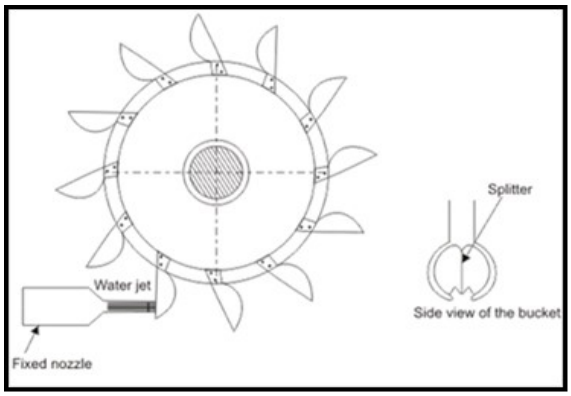
Which can be used to produce heat energy. This heat energy is used to produce high pressure and high temperature steam. This steam is used to run the steam turbine. Steam turbine is coupled with generator to produce electrical energy.

Q.6	Attempt any TWO of the following	12 Marks
a)	**Explain with sketches the construction and working of the Pelton turbine used for high head power plant.**	

Ans:

(Diagram : 2 Marks, Construction : 2 Marks & Working : 2 Marks, Total 6 Marks)

Diagram of Pelton Wheel:- **(2 Marks)**



OR equivalent Sketch

Construction : **(2 Marks)**

The various parts of the Pelton turbine are:

1. Nozzle and Flow Regulating Arrangement (Spear)

Nozzle is used to increase the kinetic energy of the water that is going to strike the buckets or vanes attached to the runner.

The quantity of water that strikes the buckets is controlled the spear. It is a conical needle present in the nozzle automatically in an axial direction.

When the spear is move backward the rate of flow of water increases and when it is pushed forward the rate of flow of water decreases.

2. Runner and Buckets

Runner is a rotating part of the turbine. It is a circular disc on the periphery of which a number of buckets evenly spaced are fixed.

The buckets are made by two hemispherical bowl joined together.

The buckets of the Pelton turbine are made up of cast iron, cast steel bronze or stainless steel.

3. Casing:

The outer covering of the turbine is called casing.

It prevents the splashing of the water. It protects the runner, runner buckets and other internal parts of the turbine from an external damage.It also acts as a safeguard in the case of any accident occurs. Cast iron or fabricated steel plates are used to make the casing of the Pelton Turbine.

4. Breaking jet:

In order to stop the runner in the shortest possible time a small nozzle is provided which directs the jet of water at the back of the vanes. This jet of water used to stop the runner of the turbine is called breaking jet.

Working of Pelton wheel: **(2 Marks)**

The water stored at high head is made to flow through the penstock and reaches the nozzle of the Pelton turbine.

The nozzle increases the K.E. of the water and directs the water in the form of jet.

The jet of water from the nozzle strikes the buckets (vanes) of the runner. This made the runner to rotate at very high speed.

The quantity of water striking the vanes or buckets is controlled by the needle valve present inside the nozzle.

The generator is attached to the shaft of the runner which converts the mechanical energy of the runner into electrical energy.

b)	**Describe the features of solid, liquid and gas biomasses as fuel for biomass power plant.**
Ans:	**(2 Marks each ,Total 6 Marks)**

Features of solid biomasses fuels:-

1. Ash is high.
2. Low thermal efficiency
3. Low calorific value and require large excess air.
4. Cost of handling high

Features of liquid biomasses fuels:-

1. High calorific value
2. No ash produces

3. Ignite easily
4. Firing can be controlled easily

Features of Gaseous biomasses fuels :-

1. High calorific value
2. No ash produces
3. Ignite easily
4. Firing can be controlled easily

OR

Biomass fuels:-

1. Bagasse (Sugar cane waste)
2. Agriculture residual
3. Forestry residual
4. Energy trees/crop plantation/energy crops
5. Dead trees and tree branches
6. Wood processing industrial waste
7. Food processing industrial waste
8. Horticulture
9. Residential, commercial and industrial waste
10. Municipal waste
11. Hotels, resorts waste
12. Peels of fruits
13. Coconut shell
14. Ground nut shell
15. Vegetable waste

c)	**The peak load on a power station is 30 MW. The loads having maximum demands of 25 MW, 10 MW, 5 MW and 7 MW are connected to the power station. Capacity of the power station is 40 MW and annual load factor is 50%. Find: (i) Average load on power station (ii) Energy supplied per year (iii) Demand factor (iv) Diversity factor**
Ans:	**Solutions:**

i) The maximum demand on the power station is **30 MW**

Maximum Demand: 30 x 10^3 KW ---------- **(1 Mark)**

ii) Energy supplied by the plant in year =

$$= M.D \times L.F \times 8760$$

$$= 30 \times 10^3 \times 0.50 \times 8760$$

$$= 131400000$$

$$= 131400 \times 10^3 \ KWh$$ ---------- **(1 Mark)**

iii)Average Load =

$$= \frac{Units\ generated\ in\ plant}{8760}$$ ---------- **(1/2 Mark)**

$$= \frac{131400 \times 10^3}{8760} = 15 \times 10^3 \ KW$$

$$= 15 \times 10^3 \ KW$$ ---------- **(1 Mark)**

iv) Diversity Factor =

$$= \frac{Sum\ of\ individual\ consumer\ M.D}{Maximum\ demand\ on\ generating\ Station}$$ ---------- **(1/2 Mark)**

$$= \frac{10^3\ (25+10+5+7)}{30 \times 10^3}$$

= 1.5666 ---------- **(1 Mark)**

v) Demand Factor =

$$= \frac{Maximum\ Demand}{Install\ Capacity\ of\ the\ power\ Station}$$

$$= \frac{30 \times 10^3}{40 \times 10^3}$$

$$= 0.75$$ ---------- **(1 Mark)**

$$= 75\ \%$$

----------END----------