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 TEN of the following**	**20 Marks**
a)	**Write the functions of re-heater in steam plant.**	
Ans:	**Functions of re-heater:-** **(2 Marks)** In Re-heater temperature of exhausted steam from HP turbine is increased by passing exhausted steam again to boiler.	
b)	**What are the steam prime movers?**	
Ans:	**(2 Marks)** Steam prime movers are machines which convert heat energy in to mechanical energy **OR** Steam prime movers are i) Impulse Type ii) Reaction Type	
c)	**What is penstock? What is its function?**	
Ans:	**What is Penstock:-** **(1 Marks)** The penstock is the long pipe line. It consists of heavy duty steel pipe. **Function of Penstock:-** **(1 Marks)** Function of penstock is to carry water from the water intake (reservoir) to turbine.	
d)	**List out purpose and functions of power house.**	
Ans:	NOTE:-Credit may be given by judgment of relevant answer based on candidate understands. **Purpose of power house: -** Is to cover turbine and alternator unit or housing the generating units. **(1 Marks)**	

	Function: - **(1 Marks)** Function of power house is to protect turbine and alternator unit from outside (Atmospheric) impact.
e)	**Write function of control rods in nuclear power plant.**
Ans:	**Function of control rods in nuclear power plant:** **(2 Marks)** The function of control rod is to control the chain reaction in reactor core by adjusting its height.
f)	**Write down any two advantages of nuclear power station.**
Ans:	**Advantages of Nuclear Power Station:** **(Any Two advantages are expected : 1 Mark each, Total 2 Marks)** 1. Nuclear fuels do not produce carbon dioxide & sulfur dioxide from flue gases so it produces less air pollution than thermal power plant. **2.** Quantity of waste produced: Quantity of waste produced is very small as compre to Thermal Power Plant. 3. Fuel required: Fuel requirment of Nuclear Power Plant is less than Thermal Power Plant. So it reduces transportation cost of fuel and space required for fuel storage. 4. Nuclear reactor needs little fuel, once reactor is charged there is no need of fuel for 3 to 6 years. 5. Generating capacity: Nuclear Power Plant can be built of large generating capacity and is very economical for producing bulk amount of electrical power. 6. Nuclear energy is outstanding and reliable as compare to any other type of energy sources. 7. Availability of fuel : Large amount of nuclear fuel is availabe in nature than coal . 8. Space require Nucler power plant require less area as compared to Thermal Power Plant and HydroPower Plant of the same capacity. 9. Nuclear power plant are not affected by adverse weather conditions. 10. By use of nuclear fuel,it saves the other fossile fuels like-coal, gas, oil, etc.

g)	**Name the different types of engines in diesel power plant.**
Ans:	**Different types of Engines in Diesel Power Plant:** **(2 Marks)** i) Two stroke diesel engine ii) Four stroke diesel engine
h)	**Define each of following terms: i) Connected load ii) Spinning reserve.**
Ans:	**i) Connected Load :-** **(1 Marks)** It is the sum of load of all equipments connected to supply system which are in use or not in use of each consumer. **ii) Spinning Reserve:-** **(1 Marks)** It is reserved generating capacity in operation and connected to bus bar and ready to take a load.
i)	**What is the choice of size and number of generator units in interconnected power system?**
Ans:	**(Any Two Points are expected : 1 Mark each Point, Total 2 Marks)** NOTE:-Credit may be given by judgment of relevant answer based on candidate understands. **Choice of Size and Number of Generating Units:** 1. The size/rating and number of generating units in such way that they approximately match with the load 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
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.

j) Define the term solar constant.

Ans: **Solar Constant:** **(2 Marks)**

The rate at which solar energy arrives at the top of the atmosphere is called the solar constant.

OR

The intensity of solar irradiation directly outside the earth's atmosphere on a horizontal surface is almost constant at around 1,360 or 1367 or 1370 W/m^2., the so-called "*Solar Constant*".

k) State the meaning of following terms: i) Power in wind ii) Maximum power.

Ans: **i) Power in wind:-** **(1 Marks)**

Total power available in the wind is equal to the product of mass flow rate of wind and $\frac{V^2}{2}$ (V is velocity of wind) [i.e. K.E $\frac{1}{2}$ mV^2]

OR

- The power in the wind is:

$$\text{Power} = \tfrac{1}{2}\,\rho\, A\, V^3$$

= 1/2 x air density x swept rotor area x (wind speed)^3

	ii) Maximum Power:- **(1 Marks)** **Betz's law** indicates the maximum power that can be extracted from the wind, independent of the design of a wind turbine in open flow. According to Betz's law, no turbine can capture more than 16/27 (59.3%) of the kinetic energy in wind. **OR** ▫ Theoretical maximum energy extraction from wind = 16/27 = 59.3%
l)	**State the types of wind turbines.**
Ans:	**The types of Wind Turbines:-** **(2 Marks)** **1)** Vertical axis wind turbine (VAWT) **2)** Horizontal axis wind turbine (HAWT) i) Up wind HAWT ii) Down Wind HAWT **OR** **The types of wind turbines:-** 1. Small size wind turbine 2. Medium size wind turbine 3. Large size wind turbine
Q.2	**Attempt any FOUR of the following :** **16 Marks**
a)	**What is renewable source of energy? State two examples for the same.**
Ans:	**Renewable (Primary) Energy sources:** **(2 Marks)** It is defined as the sources that can be used again and again for the generation of electrical energy are called renewable. **Following are the some list of renewable energy sources:-** **(Any Four Example are expected : 1/2 Mark each, Total 2 Marks)** **1. Solar Energy** i) Photovoltaic Systems (Direct conversion to electricity) ii) Solar Thermal Power plant (In direct conversion to electricity) **2. Wind Energy** **3. Hydropower** **4. Ocean Energy** i)Ocean Tidal Energy ii)Ocean Wave Energy

iii)Ocean Thermal Energy

5. Bioenergy:-

i) Biofuels (e.g. Bio-diesel, Ethanol)

ii) Biomass (e.g. sugar cane bagasse, farming waste, forestry waste etc.)

iii) Biogas (it is produced from any organic waste materials. It contains mixture of methane (50-65 % in volume) and carbon dioxide

6. Geothermal Energy

Geothermal Electricity Production

7. Fuel Cells

b) Give examples of different types of fuels. Also state any two advantages of liquid fuels over solid fuels.

Ans: Examples of different types of fuels:-

(Any Two Examples are expected : 1 Mark each Point, Total 2 Marks)

1. **Indian Coal :** It contain 30 to 40 % ash but sulphur content is less than 1%..
2. **Imported coal**: It contents low ash about 10% but sulphur content is more (1.2%).
3. **Liquid fuels:** Oil, diesel can be used to generate steam but it is not economical.
4. **Gases fuel:** Natural gas or manufactural gas can be used to generate steam.
5. **Biomass fuel:** Solid biomass fuel can be used to generate steam by burning directly in furnace. e.g. Agriculture waste, forestry waste, vegitable waste, commercial waste ,animal waste ,crops refuses, peel (cover) of fruits, domestic refuses etc.
6. **Bagasse:** -Waste of sugar cane.
7. **Nuclear Fuel:** Heat is produced by chain reaction of U^{235}.

OR

Natural Fuels	Manufactured Fuels
Solid Fuels	
Wood Coal Oil shale	Tanbark, Bagasse, Straw Charcoal Coke Briquettes
Liquid Fuels	
Petroleum	Oils from distillation of petroleum Coal tar Shale-oil Alcohols, etc.
Gaseous Fuels	
Natural gas	Coal gas Producer gas Water gas Hydrogen Acetylene Blast furnace gas Oil gas

Advantages of liquid fuels over solid fuels:-

(Any Two Advantage are expected : 1 Mark each Point, Total 2 Marks)

1. Less furnace volume required.
2. It requires low air pressure.
3. Firing of liquid fuel is easy.
4. No ash produces.
5. Time required for combustion reduces.
6. Liquid fuels can be transported easily through pipelines whereas solid fuels cannot be transports in this way.
7. Liquid fuels have higher calorific values than the solid fuels.
8. Due to liquid fuel amount fuel required to produce same amount of heat reduces.
9. It gives more heating surface area.
10. High temperature can be produce in furnace.
11. The requirement of air for complete combustion is reduced.
12. The firing can be controlled to match the load requirements.
13. Rapid and efficient starting of the boilers from cold.

c) State any four factors governing Selection of site for thermal power station.

Ans: **(Any four factors governing selection of site are expected : 1 Mark each, Total 4 Marks)**

Following points are considered while selecting site for thermal power station:-

1. **Distance from coal mines :-**

The power plant should be located near the coal mines, to reduce cost of transportation.

2. **Availability of Water :-**

Plant should be located near large water reservoir, lake, river or ocean as water is as good as secondary fuel.

3. **Distance from populated area:-**

As TPP produces air pollution, PP should be located away from populated area.

4. **Easy access:-**

There should be easy access towards site of power plant for transportation of construction material, machinery, equipments, man power, fuel etc.

5.Near Load Centre:-

Power Plant should be located near load center to reduce transmission cost & Losses in transmission line.

6. **Availability of land :-**

Sufficient large space should be available to build the power plant, for storage of coal, for storage of ash, for staff quarters and also for Future expansion of the power plant.

7. **Condition of land soil:-**

The land should have high bearing capacity for better foundation of machinery, equipment and buildings.

Also, the plant should be constructed on plane land.

8. **Cost of land :-**

Cost of land should be less to reduce capital cost of power plant.

9. **Away from airport:-**

As height of chimney is very high, it should be located away from airport.

10. **Earthquake:-**

Area should be free from earthquake and other natural hazards.

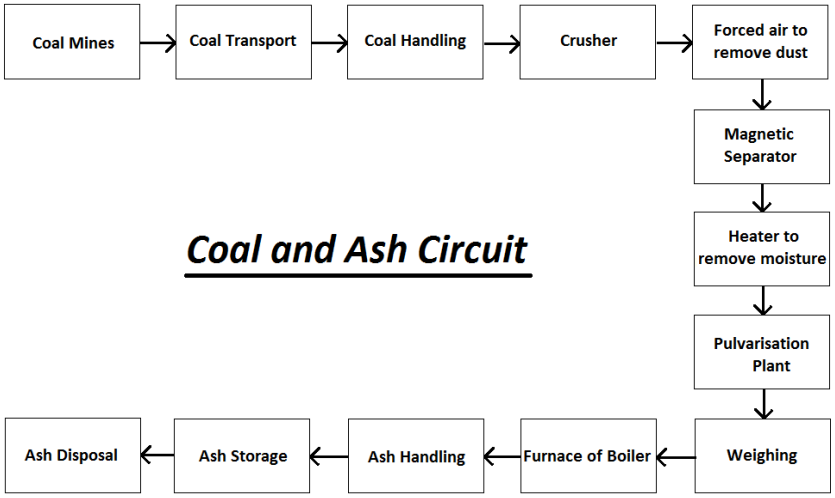
11. **Availability of labour:-**

Skilled and unskilled labour should be available nearby.

d) With the help of schematic diagram, state various stages in coal handling unit.

Ans: NOTE:-Credit may be given by judgment of relevant answer based on candidate understands.

Schematic diagram, state various stages in coal handling unit : **(4 Marks)**



or equivalent figure

e) List any four hydro-electric power plants in Maharashtra with their location and capacity.

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

(Any four locations are expected : 1 Mark each location, Total 4 Marks)

S.No	Location	Capacity
1	Koyana	1960MW
2	Mulshi Dam	150MW
3	Jayakwadi	12 MW
4	Chadholi(Warana)	16MW
5	Paithon/Ujjani	12 MW
6	Bhira Tail Race	80 MW
7	Veer	9 MW
8	Bhatghar	16 MW
9	Vaitarana Dam	1.5 MW
10	Tillari	60 MW
11	Eldary	22.5 MW
12	Radhanagri	4.8 MW
13	Paitan	12 MW
14	Pawan	10 MW
15	Panshet	8 MW
16	Varasgoan	8 MW
17	Kanher	4 MW
18	Bhatsa	15 MW
19	Dhom	2 MW
20	Manikdoh	6 MW
21	Yeoteshwar	0.075 MW
22	Dimbhe	5 MW
23	Surya	6 MW
24	Surya R.B	0.75 MW
25	Terwabnedhe	0.2 MW
26	Dudhgaon	24 MW
27	Bhandara	34 MW
28	Pench project	53 MW
29	Bhivapuri (TATA)	72 MW
30	Khopoli (TATA)	72 MW
31	Bhira (TATA)	150 MW

f) **State the significance of following terms : i) Hydrology ii) Surface run-off iii) Evaporation iv) Precipitation**

Ans:

i) Hydrology:- **(1 Marks)**

It may be defined as the science which deals with the depletion and replenishment of water resources. **OR**

To study hydrological cycle i.e. i.e. evaporation, precipitation and to estimate the yearly possible flow.

ii) Surface run-off:- **(1 Marks)**

It is that portion of precipitation (rain fall) which actually flow towards stream, lake, river or ocean.

Run-off = Total precipitation – Total evaporation of water

iii) Evaporation:- **(1 Marks)**

It is the transfer of water from liquid state to vapour state.

iv) Precipitation:- **(1 Marks)**

Precipitation is nothing but rain fall. This includes all the water that falls from atmosphere (sky) to the earth surface.

Q.3 **Attempt any FOUR of the following :** **16 Marks**

a) **Distinguish between fire tube and water tube boilers in steam power plant.**

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

Sr.No	Fire Tube boiler	Water Tube boiler
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 for per hour is less.	Rate of steam generation for 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.

b) Define natural, mechanical, forced and induced draught systems.

Ans:

Natural draught system: - **(1 Mark)**

When the fuel is burnt (combustion) in the furnace due to natural circulation of air, the draught is called natural draught.

Mechanical draught system: - **(1 Mark)**

- In a mechanical draught device (fan/blower) is used to create the pressure is called mechanical draught.

Forced draught system: - **(1 Mark)**

- If the air is circulated in combustion chamber with the help of fan/blower, the draught used is called forced (artificial) draught. **OR** Its function is to provide forced air (oxygen) for combustion process in furnace. **OR** If fan/blower is placed before the furnace then it is called as forced draught

Induced Draught system:- **(1 Mark)**

- Its function is to remove rapidly flue gases (smoke) from the furnace chamber produced during combustion. **OR** If fan/blower is placed after the furnace then it is called as induced draught
-

c) State the function of following elements: i) Storage reservoir ii) Intake iii) Trash rack iv) Tail race.

Ans:

i) Function of Storage reservoir:- **(1 Marks)**

Its function is to store the water during rainy season and supplies the same throughout the year.

ii) Function of Intake:- **(1 Marks)**

- The water from reservoir is released and controlled by opening & closing gates. **OR**
- When the intake gates are opened the water flows due to gravity towards water ways.

iii) Function Trash rack:- **(1 Marks)**

- Its function is to avoid entry of debris (solid particles, large fish, ice, etc.) going towards the turbine. **OR**
- It avoids choke up of penstock and damage to turbine due to solid particles.

iv) Function Tail race:- **(1 Marks)**

- To carry the water leaving from turbine. **OR** Tailrace path of water is connected to the next stage of generation/river/lake/ ocean.

d) Classify hydro-electric power plants according to water flow regulation and explain in brief.

Ans: Classification of hydro-electric power plants according to water flow regulation of water flow:- **(1 Marks)**

1. Large reservoir power plant
2. Run-off river (ROR) power plant with poundage
3. Run-off River (ROR) power plant without poundage

Explanation:- **(Any Two Points From The Following or Equivalent Points are Expected not all)**

1. Large reservoir power plant:- **(1 Marks)**

- These plants have large reservoir by constructing large dam
- Surge tank is compulsory.
- It has large generating capacity.
- Initial cost is high
- The main purpose of this plant is to generate electricity.

2. Run-off river (ROR) power plant with poundage:- **(1 Marks)**

- These plants store water in poundage by constructing small dam
- Fore bay acts as a surge tank
- Generating capacity of these plants depends upon size of poundage
- Initial cost is medium
- The main purpose of such power plant is to store water mainly for drinking,

agricultural purpose and secondary purpose is to generate electricity.

3. Run-off River (ROR) power plant without poundage:- **(1 Marks)**

- These plants do not store water.
- No surge tank
- Generating capacity of these plants depends upon rate of flow of water
- Initial cost is less
- Its purpose is to generate electricity.

e) List any four nuclear power plants in India with their location and capacity.

Ans: **(Any four nuclear power plants in India with their location and capacity expected: 1 Mark each, Total 4 Marks.)**

S.No	Power Station	Location	State	Total capacity (MW)
1	Tarapur atomic PS	Tarapur	Maharashtra	1400
2	Madras APS	Kalpakkam	Tamilnadu	440
3	Madras APS	Kalpakkam	Tamilnadu	500
4	Kaiga NPP	Kaiga	Karnataka	600 220 MW under construction
5	Kakrapur APS	Kakrapur	Gujrat	440 1400
6	Kudan kulam NPP	Kudan kulam	Tamilnadu	2000 2000
7	Narara APS	Narara	Uttar Pradesh	440
8	Pajushtan APS	Rawatbhata	Rajushtan	1180

f) State any four factors for selecting location of nuclear power plant.

Ans: **(Any four factors for selecting location of nuclear power plant are expected: 1 Mark each, Total 4 Marks.)**

Following points should be considered while selecting Power Plant location:-

1) **Availability of water**:

Water is as good as a secondary fuel, so ample amount of water should be available near Power Plant so power plant should be located near sea shore, ocean, river etc.

2) **Distance from populated area**:

From the safety point of views, power plant should be located away from populated area.

	3**) Easy Access:** There should be easy acces towards site of power plant for transportation of machinery,equipments, fuel and man power etc. 4) **Condition of land soil:-** Soil should have high bearing capacity .For better foundation of machinery, equipment and building. 5) **Availability of land :-** Sufficient land should be available for short storage of radioactive waste, for staff quarters and for future expansion of Power Plant. 6) **Cost of land:** Cost of land should be less, to reduce capital cost of power plant. 7) Plant should be constructed on plain land. 8**) Distance from load center :** Power Plant should be located near load centre to reduce transmission cost & transmission Losses. 9) **Distance from airport:-** As height of chimney is very high, it should be located away from airport. 10) **Area free from earthquake:** Area should be free from earthquake and natural hazards.
Q.4	**Attempt any FOUR of the following : 16 Marks**
a)	**State the location and function of i) Economizer ii) Feed water heater.**
Ans:	**(i) Economizer:-** **Location**: - **(1 Mark)** It is placed in the path of flue gases in between the exit from the furnace and the chimney. OR In The way of feed water before boiler. **Function**: - **(1 Mark)** The function of economizer is to increase the temperature of feed water, by absorbing heat from exhausted hot flue gases.

ii) Feed water heater:

Location: - **(1 Mark)**

It is placed in between the condenser and the economizer. OR In The way of condensate before economizer.

Function: - **(1 Mark)**

Its function is to increase the temperature of feed water by using blade steam.

b) Explain ash disposal and dust collection in a thermal power plant.

Ans:

NOTE:-Credit may be given by judgment of relevant answer based on candidate understands.

Ash disposal:- **(2 Marks)**

Various methods of disposal of ash are:

- Mechanical handling system.
- Pneumatic system.
- Hydraulic system
- Steam jet system

Commonly used ash handling equipments are:-

- Belt conveyer
- Pneumatic conveyer
- Bucket conveyer
- Bucket elevator
- Screw conveyer
- Hydraulic sluicing equipment
- Trollies or rail etc.

Dust collection: - **(2 Marks)**

(Credit may be given by judgment on part of relevant answer based on candidate understands.)

1. **Removal of ash from**:-

In furnace, this is collected in ash hopper installed at the bottom of furnace.

Economizer dust(Ash) handling System: -

In economizer ash is trapped; it is **evacuated continuously**, which is collected in ash hopper.

Air Pre Heater dust(Ash) handling system: -

In air-preheater ash is trapped; it is evacuated **once in a shift**, which is collected in ash hopper.

Fly dust(Ash) Handling System: -

In ESP fly ash is collected; Fly ash in ESP is collected in ESP Hoppers.

2. Load on conveyer belt.
3. Deliver to the space where it can be disposed off.

OR

Working Of Dust Collector(ESP**):-**

- ESP is located in the path of flue gasses near chimney.
- The first electrode is charged to a very high negative voltage.
- As the flue gasses with fly ash (dirt) particles move over it, they pick up a negative charge.
- There's a second electrode consisting of metal plates charged to a high positive voltage (30kV to 60kV D.C. depending upon the electrodes spacing).
- The negatively charged fly ash particles are attracted to the positively charged plates and stick there.
- In this way only flue gasses without fly ash are passed towards chimney so air pollution reduces.
- From time to time, the collecting plates have to be cleaned by mechanical vibrations created by rapping the collecting plate & use a rotating brush to remove the collected dust. That can be done either manually or automatically.
- This removed fly ash is collected in separate container

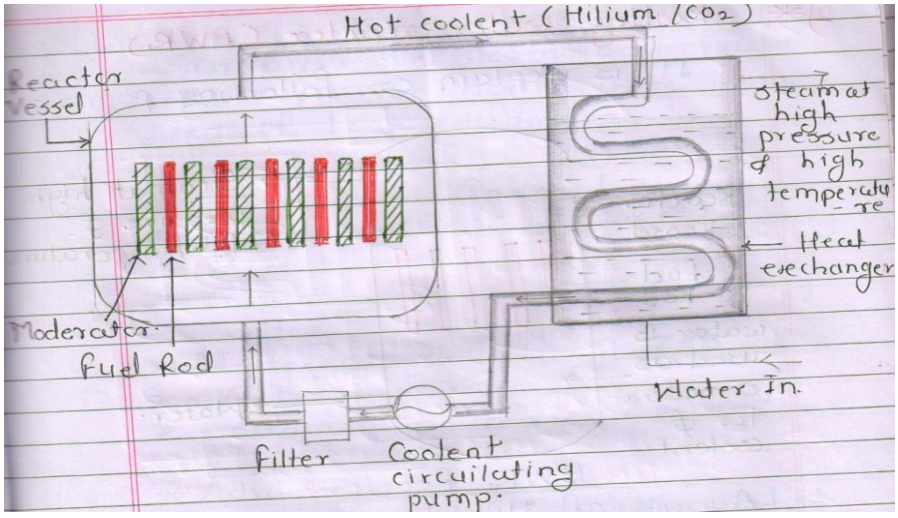
c) List out any four salient features of hydro generator.

Ans: **(Any four salient features of hydro generator or equivalent are expected 1 Mark each, Total 4 Marks)**

Following are the salient features of hydro generator:-

1. Alternator is larger in diameter and smaller in axial length.
2. Salient pole type rotor is used in the
3. Typically number of salient poles is between 4 to 60.
4. They are generally having lower speed electrical machines, say 100 RPM to 1500 RPM.
5. Windage loss as well as noise is more as compared to **hydro generator** (cylindrical rotor).

d)	**What is mass energy equivalence? Give one example. Define mass defect and binding energy.**
Ans:	**Mass energy equivalence:-** **(1 Mark)** The physical principle that a measured quantity of **energy** is equivalent to a measured quantity of **mass**. The **equivalence** is expressed by Einstein's equation $E = mc^2$, where E represents energy, m the equivalent **mass**, and c the speed of light. **Give one example**:- **(1 Mark)** For example, the collision of an electron and a proton annihilates the mass of both particles, but creates energy in the form of photons. **Mass defect:-** **(1 Mark)** We know that atomic nucleus consists of proton and neutron. It is found that measure mass of a nucleus is always less than. The sum of masses of the individual protons and neutrons which makes it up. This is known as mass defect. **OR** We know that an atom consists of protons, neutrons, and electrons; each one of which possesses a finite mass. However, the weight of an atom is always less than the sum of the weights of its protons, neutrons, and electrons. The difference is known as the *mass defect*. **Binding energy:-** **(1 Mark)** The energy required to split (to overcome) nucleus of an atom into its component parts. The components parts are protons and neutrons. **OR** Binding energy is defined as the amount of energy that must be supplied to a nucleus to completely separate its nuclear articles (nucleons)
e)	**State the term nuclear fuel. Also state its properties.**
Ans:	NOTE:-Credit may be given by judgment of relevant answer based on candidate understands. **The term nuclear fuel:-** **(3 Marks)** **Nuclear fuel** is a substance that is used in nuclear power stations to produce heat to power turbines. Heat is created when nuclear fuel undergoes nuclear fission. **OR** Nuclear fuel is in the from of rod kept in core. It produces heat energy during fission process. Following nuclear fuel are used in nuclear power palnt:- 1. Natural Uranium 2. Low –enriched Uranium 3. Highly –enriched Uranium 4. Fertile Material:- U^{238} / Th^{232}

	Properties:- **(1 Marks)** 1. Nuclear fuel has the highest energy density 2. Nuclear fuels contain heavy fissile elements 3. Nuclear fuels are complex, multi-component materials containing actinides
f)	**State the functions of following elements: i) Diesel engine system ii) Air intake system iii) Engine exhaust system iv) Engine starting system.**
Ans:	**i) Diesel engine system:-** NOTE:-Credit may be given by judgment of relevant answer based on candidate understands. **(1Mark)** ➢ Four strokes ➢ Two strokes **ii) Air intake system:-** **(1Mark)** Air intake system is provided to supply air to engine cylinder for fuel combustion. **iii) Engine exhaust system: -** **(1Mark)** This system is provided to discharge the engine exhaust (smoke) to the atmosphere outside the building. **iv) Engine starting system:-** **(1Mark)** This system is provided to rotate the engine initially until the firing starts and engine run under its own power.
Q.5	**Attempt any four of the following :** **16 Marks**
a)	**Explain the operation of advanced gas cooled reactor.**
Ans:	**Advanced Gas cooled reactor (AGR):** **(Explanation: 2 Marks & Figure: 2 Marks)**  **or equivalent figure**

Operation:-

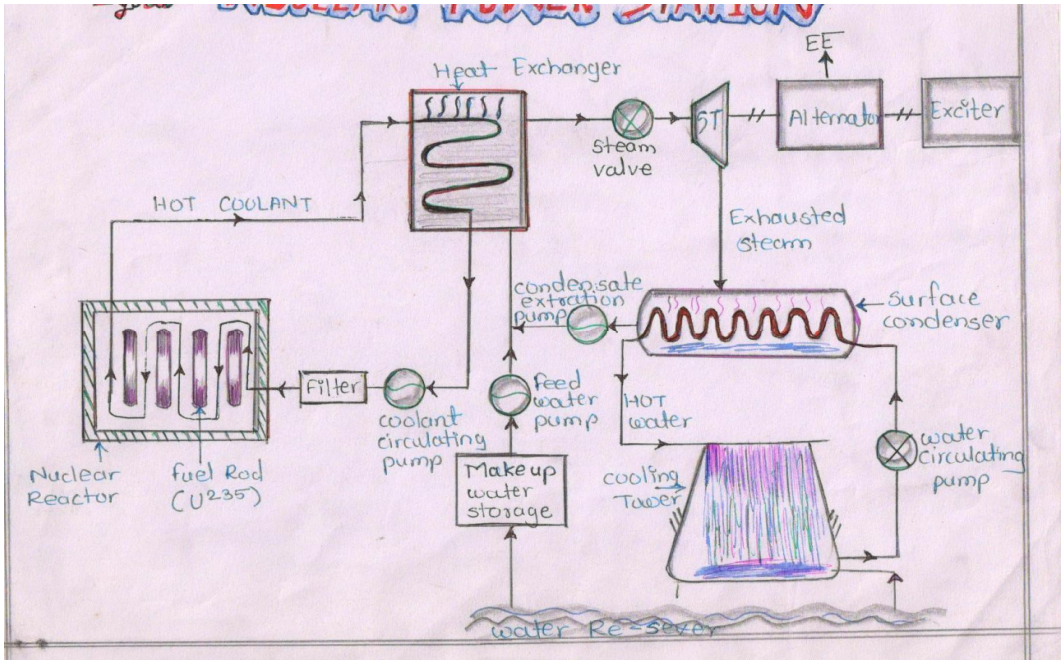
Carbon dioxide or Helium is the gas used for transferring the heat produced form the reactor core to the Heat exchanger. The gas is pumped through the reactor core at high pressure. In heat exchanger steam is generated at high temperature and high pressure. Cooled gas is drawn from the Heat exchanger and passed in reactor core and cycle is repeated.

OR

- Fuel used in Uranium.
- Moderator used is Graphite.
- Coolant used is CO_2/Helium.
- Temperature obtain is 565^0C.
- The AGR was designed to have a high thermal efficiency 40 %.
- Steam pressure is 162 Kg/cm^2

b) Show the schematic arrangement and explain the working of nuclear power plant.

Ans: **Schematic arrangement of Nuclear power Station:-** **(3 Marks)**



or equivalent figure

Working of Nuclear power Station: **(1 Mark)**

In NPP, a nuclear fuel such as (U^{235}) uranium, Thorium (Th^{232}) is produces heat energy during nuclear chain reaction, in a separate special apparatus known as nuclear reactor.

This heat energy is utilized to produce steam at high pressure and high temperature, which is used to run the steam turbine to give mechanical power.

Alternator is mechanically coupled with steam turbine which converts mechanical energy into electrical energy.

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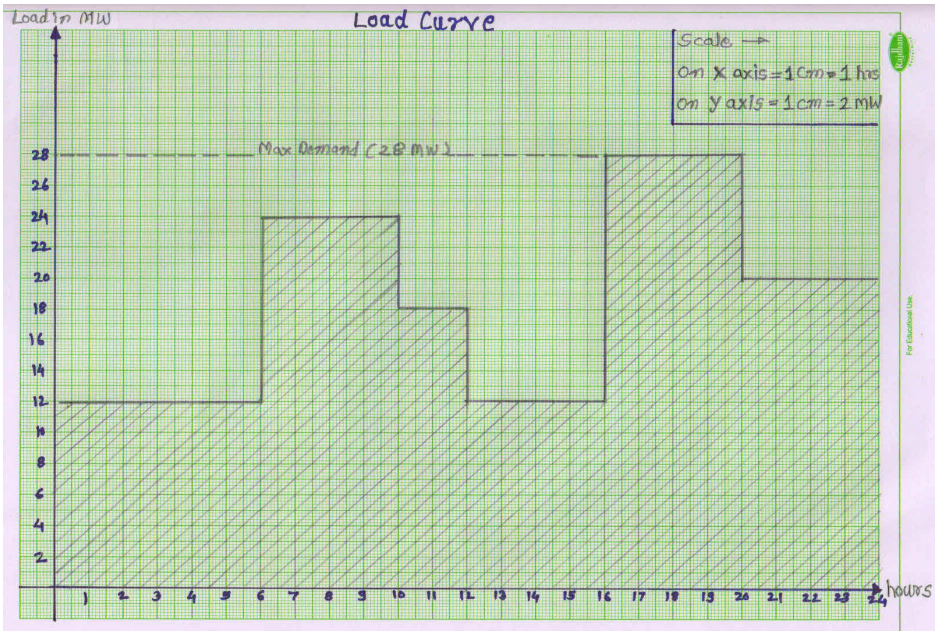
c) List out the four applications of diesel electric power plant.

Ans: **(Any Four Applications of Diesel Power Plant expected: 1 Mark each, Total 4 Mark)**

Applications of Diesel Power Plant:

1. It can be used as a standby (emergency) power plant to maintain continuity of supply. (Incase failure of main supply like hospital, Telephone exchange Radio stations, Colleges, and cinema Theaters.)
2. It is suitable where power requirement is small.(for industrial applications)
3. It is suitable as a peak load power plant for short duration.
4. It is widely used in transportation system. E.g. Elect. Traction, Ship, Aero plane etc.
5. Mobile DEPP mounted on vehicle is used in emergency requirement and for temporary supply purpose.
6. It is used in remote places where supply from grid is not possible.
7. It is very economical to supply power to small scale industry which works for seasonal period.(For short period in a year)
8. The use of such plant is very common during construction stage of HPP/TPP/NPP and other construction.
9. The diesel units can be used to supply the auxiliaries for starting the large thermal plants.
10. Diesel plants are widely used for generating power ranging from 100 to 5,000 H.P.

d)	**A generating power station has the following daily load cycle :** **Time (Hours) : 0 — 6 6-10 10 — 12 12— 16 16 — 20 20 — 24** **Load (M. W.) : 12 24 18 12 28 20** **Draw the load curve and find : i) Maximum demand ii) Units generated per day iii) Average load iv) Load factor.**
Ans:	**Load curve : (Student may take different scale to draw the graph)**



(Graph 1 Mark)

i) Maximum demand : 28 MW ---------- **(1/2 Mark)**

ii) Units generated per day :

No. of. units generated in one day in MWH =

= (12 x 6) + (24 x 4) + (18 x 2) + (12 x 4) + (28 x 4) + (20 x 4)

= 72+ 96 + 36 + 48 + 112 + 80

= 444 MWH

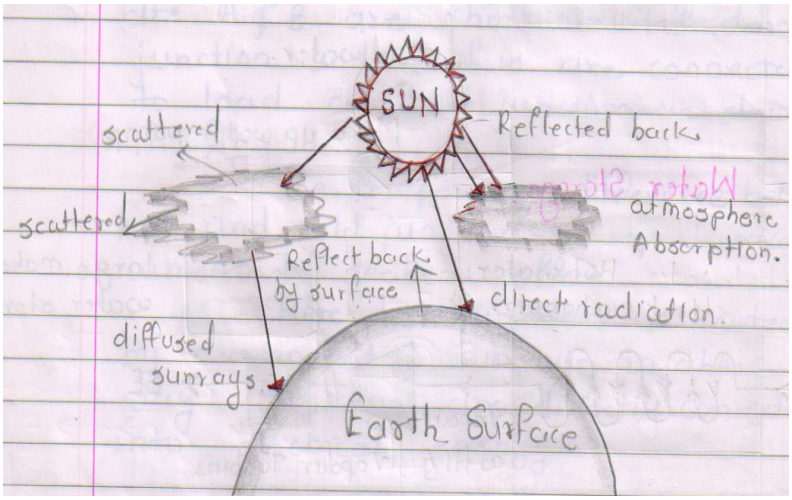
= 444×10^3 KWH ---------- **(1/2 Mark)**

iii) Average load:

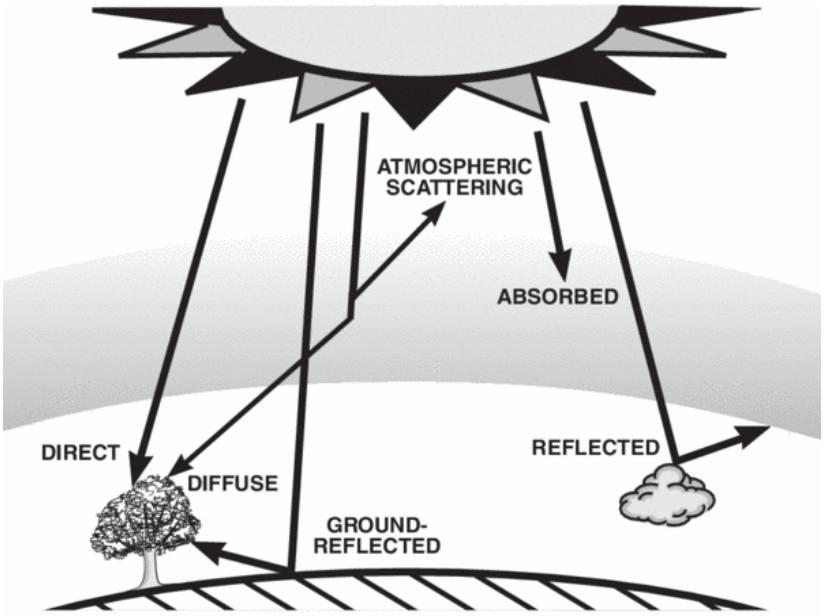
$$Average\ \ Load = \frac{No.\ of\ units\ generated\ \ in\ one\ day}{24}$$ ---------- **(1/2 Mark)**

$$Average\ \ Load = \frac{444 \times 10^3}{24}$$

	Average Load $= 18.5\ KW$ ---------- **(1/2 Mark)** **iv) Load factor:** $Load\ \ Factr = \frac{No.\ of\ units\ generated\ \ in\ one\ day}{24 \times M.D}$ ---------- **(1/2 Mark)** $Load\ \ Factor = \frac{444 \times 10^3}{24 \times 28 \times 10^3}$ $Load\ \ Factor = 0.66071$ ---------- **(1/2 Mark)** OR $Load\ \ Factor = 66.071\ \%$
e)	**Explain the importance of renewable energy sources in the energy deficient India.**
Ans:	**(Credit may be given by judgment on part of relevant answer based on candidate understands.)** **(Any 4 points from following or equivalent points are consider 1 mark to each, Total 4 Marks)** **Importance of renewable energy sources in the energy deficient India:-** ➢ India, a rapidly growing economy with more than 1.25 billion population. ➢ The demand for electricity is increasing sharply because of industrial growth, increasing use of electricity. ➢ The power produced in the country is mostly from coal (53%) and coal reserves are decreasing day by day. ➢ Many villages in the country are still without electricity. ➢ There is a need of green energy resource that is easily available and renewable. ➢ Renewable energy sources are the best form of energy to fulfill the energy needs of India. **OR** **Due to following advantages of renewable energy sources there is the importance of renewable energy sources in the energy deficient India:-** **(Any 4 points from following or equivalent points are consider 1 mark to each,**

	Total 4 Marks) Advantages:- 1. No air pollution. 2. Fuel is freely available 3. Unlimited quantity of fuel is available in day time & is inexhaustible. 4. No fuel transportation cost. 5. No waste disposal problem. 6. No fuel storage is required. 7. No treatment on fuel is required. 8. It saves the fossil fuel (coal, diesel, oil etc.) which are limited available. 9. Renewable technologies are ideally suited to distributed power generation (DPG). 10. Power can be generated at the point of utilization so it reduces transmission & distribution cost and losses in it. .(PP using PV cell) 11. It works automatically (Not required to start)
f)	**Draw schematic representation of distribution of solar energy as direct, diffuse, total radiation.**
Ans:	**Schematic representation of distribution of solar energy as direct, diffuse, total radiation.** **(4 Marks)**  **or equivalent figure**

OR



OR Equivalent figure

Q.6	**Attempt any Four of the following :** **16 Marks**
a)	**State why efficiency of thermal power station is about 29%. How it can be improved?**

Ans: **(Explanation : 2 Mark & remedies: 2 Marks, Total 4 Marks)**

Overall efficiency of T.P.P depends upon efficiency of boiler, turbine and alternator. The heat produced due to combustion of coal is not fully utilized for generation of electrical energy because there are total losses in thermal power plant is 71**%, So efficiency of thermal power plant is less about 29%**

OR

a) Boiler House losses: i) Flue gases -5 % ii) Moisture in gases-5% iii) To ash-1% iv) Radiation and leakage losse-2.5 % v) Unknown losses-2.5%

Therefore total losses in boiler-16%

b) Turbine losses: heat rejected to condenser i.e turbine losses is 54 %

c) Electrical losses- 1 %

Therefore total losses in thermal power plant is 71%, So efficiency of thermal power plant is less about 29%

	Remedies for improvement of overall efficiency of thermal power station. **(2 Marks)** **(Any four points are expected)** Following equipments are used to improve efficiency by recovering heat. 1) Economisor 2) Air preheater 3) Super heater 4) L.P and H.P water heater In addition to above efficiency of thermal power plant is incrased by 5) Condensing plant 6) Pulvarising of coal 7) By use of FDF and IDF draught system 8) Feed water treatment plant 9) Reheater (*Reheating also decreases the moisture content at the turbine exit.*) 10) By use of multistage Steam turbine instead of single stage 11) Also the average steam temperature should be as high as possible during heat addition and as low as possible during heat rejection.
b)	**List out the four advantages and four disadvantages of captive power generation.**
Ans:	**Advantages of captive power generation:** **(Any Three advantages are expected 1 Mark to each , Total 3 Marks)** 1. Transmission losses reduce as generation is near load center. 2. Reliability of supply increases. 3. Low tariff than Supply Company. 4. Surplus energy can be sale easily to other consumers. 5. Power quality is good. (Free from harmonics) 6. Reduces the load on the grid, thus reduces the need for grid up gradation. 7. CPP reduces economic loading on government to build a new power project.

8. In some industry like textile and paper manufacturing industry steam is require in manufacturing processes. Same steam can be used for generation of electricity. Thus increase efficiency of industry.

Disadvantages:- **(Any one disadvantages from the following or equivalent point is expected, 1 Mark)**

1. CPP is Bulky
2. It is Dusty and Dirty if coal fired
3. Expensive
4. Difficult to manage
5. State Electricity Regulators levy surcharges that make private sales of power is uneconomic.

c) Define each of the following terms : i) Average demand ii) Demand factor iii) Plant capacity factor iv) Plant use factor.

Ans:

i) Average Demand /Load:- **(1 Marks)**

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

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

OR

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

OR

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

OR

Yearly Demand /Average load $= \frac{KWH}{8760\ H}$

ii) Demand factor: **(1 Marks)**

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

Mathematical expression:

OR

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

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

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

Plant capacity factor

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

iv) Plant use Factor /Plant operating factor:- **(1 Marks)**

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

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

d) Compare flat plate collectors with concentrating type solar collectors.

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

Sr.No	Points	Flat plate collector	Concentrating type collector
1	Shape	Shape of collector is rectangular	Shape o collector is parabolic or disc type / Tower
2	Collector and	The Collector area is same as	The Collector/reflector area is

	absorber area	absorber area	more than absorber area
3	Design	Mechanically simple in design	Complicated in design
4	Construct	Are relatively simple to construct and erect	Difficult to construct and erect
5	Tracking	No tracking of panel is required to words sun direction	Tracking is required to words sun direction for better results
6	Uses of sun radiation	It uses both direct and diffused radiation of sun	It uses only direct radiation of sun because diffused radiation cannot be reflected.
7	Flux	Uniform flux on the collector & absorber	Non-uniform flux on the collector & absorber
8	Cloudy days	Effective even cloudy days when there is no direct radiation of sun	Ineffective in cloudy days as there is no direct radiation of sun
9	Heat losses	Heat losses are more (as absorber area is more)	Heat losses are less (as absorber area is less)
10	Efficiency	Efficiency is less	Efficiency is high
11	Temperature obtain	Temperature obtain is less (up to 90^0C)	Temperature obtain is high (up to 400^0C)
12	Heat insulation cost	Heat insulation cost is more	Heat insulation cost is less
13	Maintenance	Little maintenance	More maintenance
14	Space required	Space required is less	Space required is more
15	Anti-freeze protection	It require more anti-freeze protection	Little or no anti-freeze protection is require to protect the absorber
16	Generate steam	Not suitable to generate steam only for heating water/fluid/Air	Suitable to generate steam
17	Generate	Cannot be used to generate	Can be used to generate electricity with the help of

	electricity	electricity directly from water	steam turbine
18	Types	a) Flat plate collectors (FPC) b) Evacuated Tubular collector (ETC)	Line focusing:- Linear CC Point focusing::- Parabola CC Tower CC

e) State the principle of solar cell. What is necessity of series and parallel connection of solar cells.

Ans:

Principle of solar cell:- **(2 Marks)**

Working:-

Solar cell operates on principle of Photo-voltaic effect

Solar cell works in following steps:

- The solar cell is composed of a P-type semiconductor and an N-type semiconductor.
- When sun light (photon) is absorbed by the semiconductor material the cell produces two types, -
  - A negatively charged electron and
  - Positively charged holes are created due to photovoltaic effect.
- Negatively charged (-) electrons gather around the N-type semiconductor while
- Positively charged (+) electrons gather around the P-type semiconductor.
- When you connect loads such as a light bulb, electric current flows between the two electrodes

Necessity of series and parallel connection of solar cells:- **(2 Marks)**

- Numbers of solar cells are connected in series to increase voltage rating.
- Numbers of solar cells are connected in parallel for getting higher current rating.

So to obtain required rating of solar panel of Voltage & Current rating it is necessity of connecting series and parallel connection of solar cells.

f)	**State any four factors for selection of site of wind power plant.**
Ans:	**(Any four factors for selection of site of wind power plant: 1 Mark each Factor, Total 4 Marks)** **The Factors for selection of site for Wind Mills:** 1) The site should be selected where winds are strong i.e. where pressure of wind is high and there is continuity (14.4- 16.2 km/h) and above. 2) Wind pressure is also high in hilly area so wind turbines are located in hilly area. 3) It is better to choose a site near the sea shore i. e. ON shore (coastal area) 4) Winds turbines are also installed OFF shore (in ocean) OFF shore 5) Site should be convenient for transportation facility. 6) The cost of land should be low. 7) Plant must be installed on tall towers (45m to 149 m) because velocity of wind is more at high level. 8) A good location for a wind turbine is on high ground facing between west and south west. 9) There should be no tall obstacles within 50m of the turbine which can affect the system's overall performance 10) Possibility to connect to power grid.

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