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) **State any two gaseous fuel.**

Ans: **Two gaseous fuel:** **(Any Two Fuels are expected: 1 Mark each, Total 2 Mark)**

1. Natural gas
2. Gas
3. Biogas

OR

1. Natural Gas
2. Coal Gas
3. Bio gas

b) **State any four thermal power plants in Maharashtra with their capacities.**

Ans: **(Any Two power plant name expected: 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

c) Write function of boiler in a thermal power plant.

Ans: **Function Boiler:** **(2 Mark)**

- Its function is to generate steam at high pressure and high temperature by utilizing heat energy. Produced due to combustion of coal (fuel) in furnace.

d) State any two hydroelectric power plants in Maharashtra with their capacities.

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

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

e) Classify hydroelectric power plant according to the type of load and according to head.

Ans: **Hydro power plants are classified according to the type of load as below:** **(1 Marks)**

1. Base load power plant
2. Peak load power plant

Hydro power plants are classified according to head of water as below: **(1 Marks)**

1. Low head power plant (Below 30m)
2. Medium head power plant (30 to 300 m)
3. High head power plant (above 300m)

f) State any two nuclear power plants in India with their capacities.

Ans:

Name of the nuclear power station in India with its installed capacity:

(Any Two power plant name expected: 1 Mark each, Total 2 Mark)

Sr.No	Name of power station	Location	State	Total Capacity(MW)
1	Tarapur Atomic power station(APS)	Tarapur	Maharashtra	1400
2	Madras APS	Kalpakkam	Tamilnadu	440
3	Madras APS	Kalpakkam	Tamilnadu	500
4	Kaiga APS	Kaiga	Karnataka	660
5	Kakrapur APS	Surat	Gujrat	1840
6	Kundankulam APS	Kundankulam	Tamilnadu	4000
7	Narora APS	Narora	U.P.	440
8	Rajasthan APS	Pawatbhata	Rajasthan	1180

g) State any four factors on which location of nuclear power plant depends.

Ans:

Following factors on which located of nuclear power plant depends:

(Any Four factor expected: 1/2 Mark each, Total 2 Mark)

1) Availability of water:

The power plant should be located near sea shore or large water reservoir, Lake, river etc. Because power plant requires the large amount of water for producing steam, for condensing plant and cooling tower

2) Distance from load centre :(*Proximity to the load center*)

The power plant should be located near load centre to reduce transmission cost and losses in it.

3) Away from populated area:

From the safety point of view and due to radioactive air pollution power plant should be located away from populated area.

	4) Easy Access: There should be easy access towards the site of power plant to transport equipments, manpower and fuel etc. 5) Waste disposal (Availability of space for disposal of waste): It should have adequate space (sufficient) and arrangement for short time storage of the radioactive waste. 6) Type of land (Soil):- Land should be of good bearing (hard) capacity to reduce construction cost of power plant and for better foundation of equipment and machinery. 7) Cost of land: To reduce capital cost of power plant cost of land should be less. 8) Area free from earth quakes: Area should be free from earthquake from the safety point of view of power plant. **OR** Following Factors are to be considered:- 1. It should be located near a river/Lake or sea side. 2. It should be located away from the populated area. 3. It should be located near load centre. 4. There should be easy access towards power plant. 5. It should be adequate space & arrangement for short time storage of the radioactive waste. 6. Land should be of good bearing capacity. 7. Area should be free from earthquake.
h)	**Write function of coolant in nuclear power plant.**
Ans:	**Function of coolant:** **(2 Mark)** Coolant is medium through which the heat liberated in reactor is transferred to the heat exchanger for generation of steam.

i) State different types of engines in diesel power plant.

Ans: **Following types of engines in diesel power plant:** **(2 Mark)**

1) Two Stroke Diesel Engine
2) Four Stroke Diesel Engine

j) Write meaning of captive power generation.

Ans: **Meaning of captive power generation**

Captive power generation plant set up by any person **OR** by any co-operative society **OR** association of persons or by industry **OR** group of industries to generate electricity primarily for his own use & sell excess power to state electricity board is known as **captive power generation.**

k) Define firm power and connected load.

Ans: **Firm Power:** **(1 Mark)**

It is the power to be always available even during adverse condition.

Connected Load: **(1 Mark)**

It is the sum of continuous supply of all equipments connected to supply system which are in use or not use of each consumer. **OR**

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

l) Write difference between cold reserve and hot reserve in power plant.

Ans: **(2 Mark)**

S.No	Cold Reserve	Hot Reserve
1	It is standby generating capacity which is available for service but not in operation	It is reserved generating capacity, in operation but not in service

Q.2 Attempt any FOUR of the following : **16 Marks**

a) State any four differences between conventional energy and renewable energy sources.

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

S.No.	Points	Conventional energy	Renewable energy
i)	Availability	Limited	Unlimited
ii)	Cost of Fuel	More	Less (Free)
iii)	Amount of power generated	In large scale	Limited
iv)	Space required	More	Less

v)	Efficiency	More	Less
vi)	Firm power	There is firm power	No firm power
vii)	Pollution of air	Air gets polluted expect HPP	No air pollution
viii)	Size of selection	Different criteria for different P.P	Site should be selected at source
ix)	For example	HPP, TPP, NPP	SPP and WPP

b) State any four factors on which selection of site for a thermal power plant depends.

Ans: Following factorss are considred while selecting site for thermal power station :-

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

i) Distance from coal mines :-

The power plant should be near the coal mine ,so that cost of fuel transportation reduces. large amount of coal is required for producing steam.

ii) Availability of Water :-

Sufficient quantity of water should be available because water is as good as secondary fuel which is required for producing steam and for condensing plant. So,plant should be located near river, water resevaior as far as possible.

iii) Availability of land (Space availability) :-

The power plant should have sufficient large space available for coal storage & ash disposal.Also for Future extensions of the power station should be possible.

iv) Near Load Centre :-

Power Plant should be located near load centre to reduce transmission cost & transmission Losses.

v) Easy acces :-

There should be easy acces towards site of power plant for transfortation of machinery, man power, fuel etc. also easy acces for train, road and even ships.

vi) Cost of land :-

To reduce capital cost of power plant, cost of land should be less as sapce required is more.

vii) Condition of soil (Land):-

The land should be rocky (Hard murrum) for the better foundation of building and machianry. The soil should not be too loose or too rocky.

viii) Distance from populated area:-

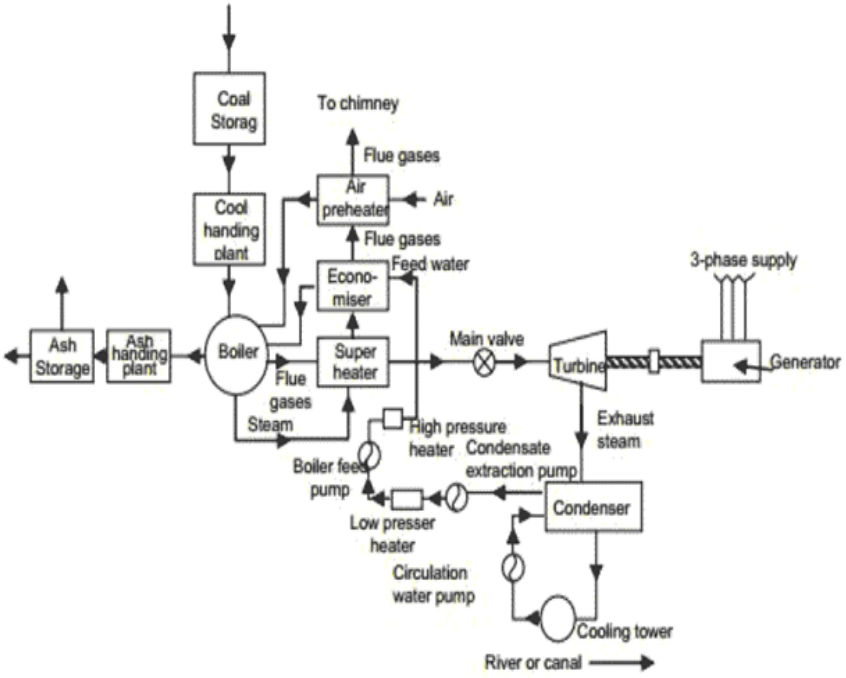
It should be located at a resionable distance away from the populated area.Because smoke & other hazards gases are produced due to combusion of the coal which causes air pollution.

ix) Availability of labour:-

Skilled and unskilled labour should be availalbe nearly.

x) To the extent possible, the thermal station should be far away from an aerodrome.

c)	**Draw a complete block diagram of a thermal power plant.**
Ans:	**Neat layout of thermal power station:** **(Figure: 2 Mark & Label it: 2 Mark)**



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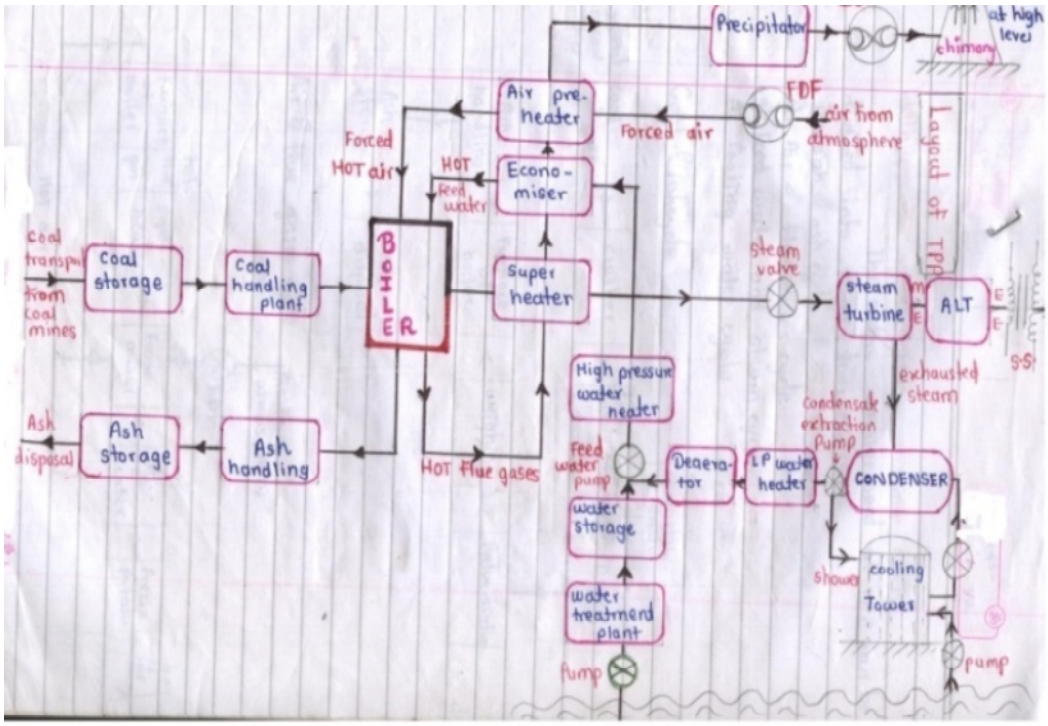

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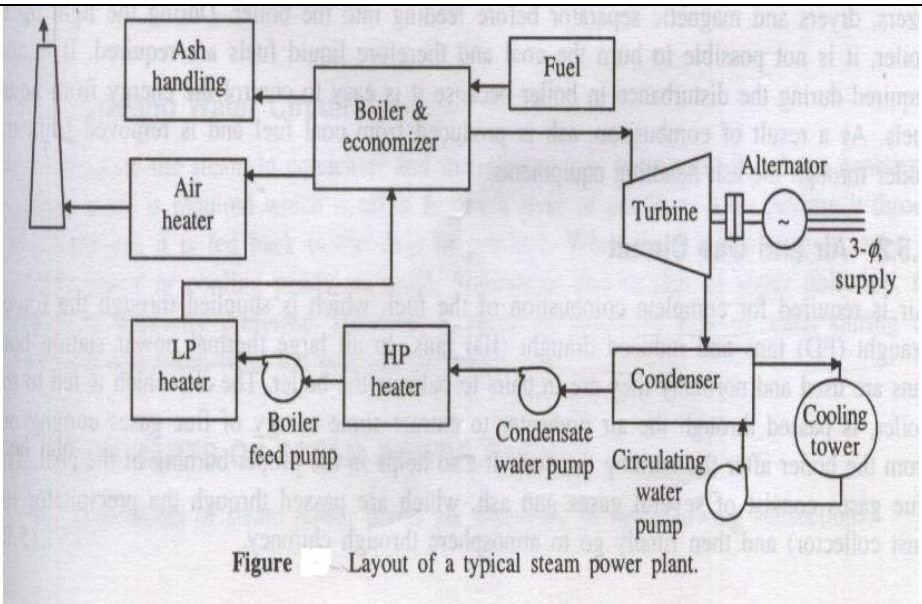


Figure Layout of a typical steam power plant.

OR Equivalent Figure

d) Explain working of superheater and condenser.

Ans:

Working of Super heater: **(2 Mark)**

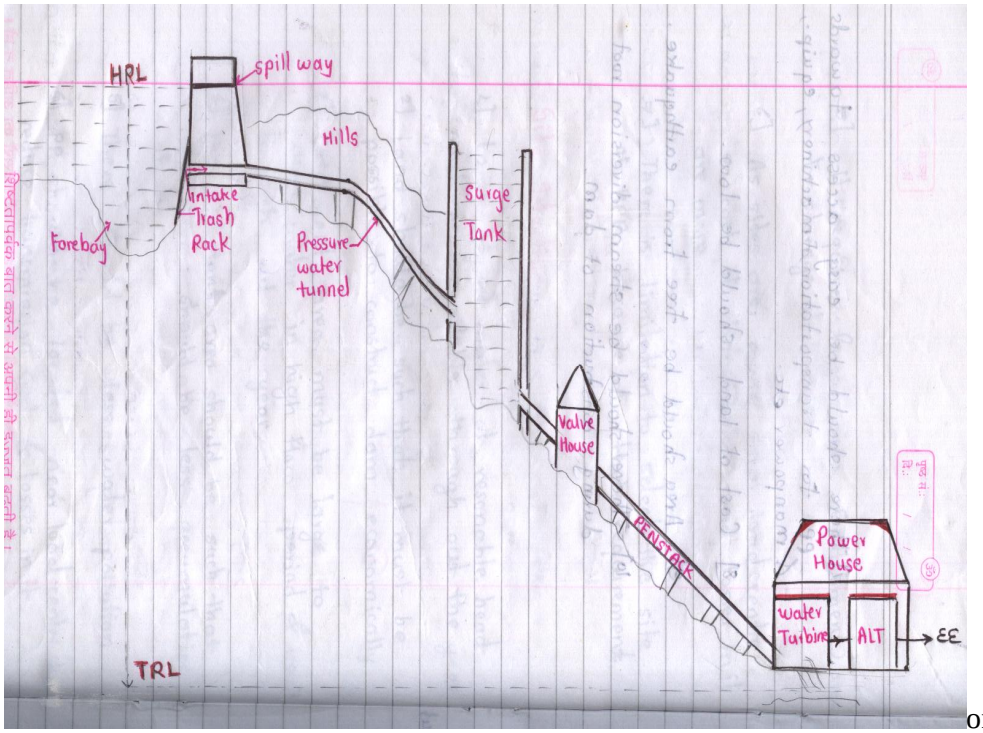
- Super heater consist of group of tubes.
- Tubes are heated by absorbing temperature of flue gases passed over it .
- 'Superheated steam' is meant that steam which contains more heat than the saturated steam
- It is a heating device.
- It is used to raise temp of steam at const pressure.
- It removes even last traces of moisture.

Working of condenser: **(2 Mark)**

- Function of condenser is to convert exhaust steam again into water by reducing its temperature with the help of cold water. OR
- Exhaust steam from turbine is passed to condenser where it is again converted into water by reducing temperature of steam with the help of cold water.OR
- In surface condenser cold water is passed through pipes and steam is passed over these pipes. So there in no direct contact between the steam and cooling water. Due to cold water steam is again converted into water called as condensate.
- This condensate is reused in boiler. This type of condenser is used for high capacity thermal power plant.

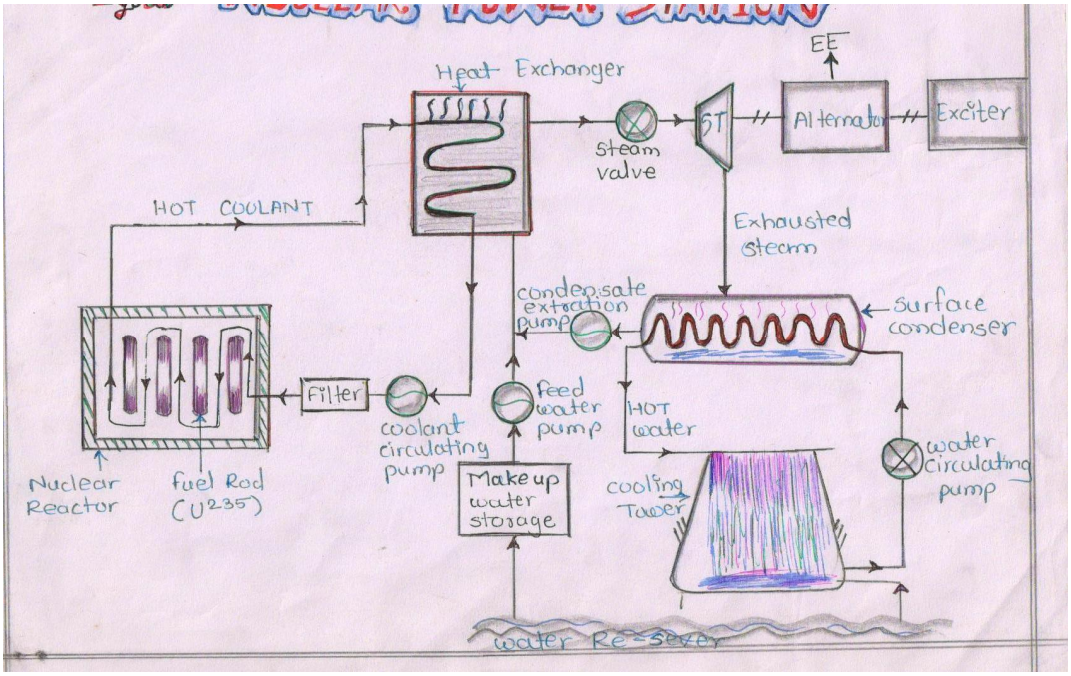
e)	**Explain how asti is disposed in a thermal power plant.**
Ans:	**Asti (Ash) is disposed in a thermal power plant:** **(4 Marks)** ➢ A large quantity of ash about 10 % produces in furnace, the removal of ash from boiler furnace is necessary for efficient combustion for this purpose ash handling unit is used. ➢ **Steps for Ash handling :-** Before handling the Ash it is desirable to quench the ash. Handling of Ash includes :- 1. Removal of ash from furnace 2. Loading of ash on conveyers belt. 3. And delivered to the space where it can be disposed off. The various methods for the disposal of ash are as follows 1. Hydraulic system. 2. Water Jetting 3. Pnumetic system 4. Mechanical ash handling system.
f)	**State any four salient features of hydro generator.**
Ans:	**Following are the salient features of a Hydro Generator (alternator):** **(Any Four Features are expected: 1 Mark each)** ➢ It is 3-ph hydro generator (alternator). ➢ It is robust in construction. ➢ A separate excitation is given to separate alternator pole by DC generator (Exciter) which is mounted on same shaft. It excites the field winding of alternator. ➢ To excite the main exciter there is pilot exciter which is of permanent magnet. ➢ The excitation voltage DC 110/220/300V ➢ Generated voltage is 3.3KV, 6.6Kv, 11KV, 17.5KV and 20 KV. ➢ Number of poles of hydro generator (alternator). is more and is various from 6 to 120 and machines are salient pole type. ➢ Hydro generator (alternator). is large diameter and small is length.

	➢ In case of generator (alternator). coupled with impulse turbine are horizontal shaft and its speed is 100-1000 rpm. ➢ In case of hydro generator couple with reaction turbine is vertical shaft and its speed is low 20-500 rpm. ➢ Hydro-generator is low speed machine compare to the steam turbine driven generator. ➢ Cooling System: The machines are air cooled, cooling is necessary to improve the performance of generator. ➢ Protection **:** 1. Protection against run away (high speed) speeds are provided 2. Over voltage under voltage protection, 3. Over load protection 4. Over & under frequency protection, 5. Over temperature protection are main protections provided to generator.
Q.3	**Attempt any FOUR of the following : 16 Marks**
a)	**Explain working of each of the following in a thermal power plant. i) induced draught ii) forced draught**
Ans:	**Draught System:** There are two draught required in thermal power plants**:** **1) Induced Draught fan (IDF): *It consists of Exhaust fan*** ➢ Its (IDF) function is to remove rapidly flue gases (smoke) from the furnace chamber produced during combustion. **OR** ➢ The fans suck the flue gases from combustion chamber and discharge it rapidly to the air through chimney. **2) Forced Draught fan (FDF): *It consists of fan*** ➢ Its **(FDF)** function is to provide forced air (oxygen) for combustion process in furnace. **OR** ➢ Its **(FDF)** function is to supply required amount of air (oxygen) to the furnace chamber for efficient and fast combustion.

b)	**Draw a block diagram of a hydroelectric power plant.**
Ans:	**Block diagram of a hydroelectric power plant: (Figure: 2 Mark & Label it: 2 Mark)**  or equivalent
c)	**State the function of each of following elements in hydroelectric power plant.** **i) dam ii) surge tank iii) penstock iv) tail race.**
Ans:	**i) Dam: (1 Mark)** It develops reservoir which has a capacity to store water. It increases storing capacity of water reservoir. And it helps to increase the working head of water. **ii). Surge Tank:- (1 Mark)** A surge tank is the small reservoir or tank. It is open at the top. It is installed near valve house. ➢ It avoids cavity effect when load on turbine increases. ➢ It avoids water hammer effect when load on turbine reduces. **iii) Penstock: (1 Mark)** It is a conduit pipeline. It function is to carry water from the water intake (reservoir) to turbine. **iv) Tail race. (1 Mark)** ➢ The tailrace is nothing but free exit of water and an unimpeded passage to the jet of water leaving the turbine. OR ➢ The water after running the turbine is to be discharged into the river/ocan/next stage of generation. For this purpose, a tailrace is required.

d)	**Explain working of nuclear power plant with block diagram.**
Ans:	**Neat Sketch of Nuclear power Station:**

(Diagram: 2 Mark & Working:2 Mark, Total:4 Marks)



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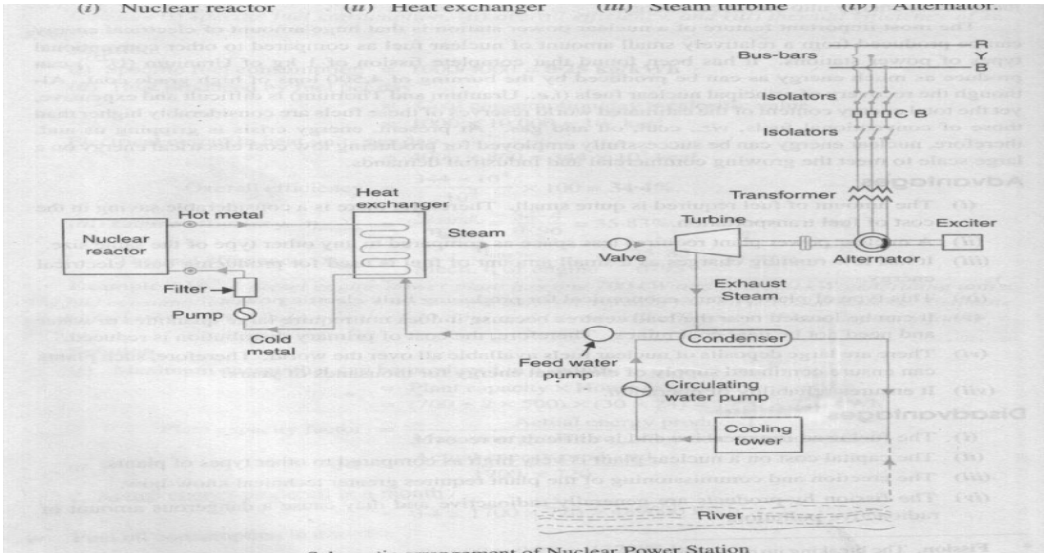


OR Equivalent Figure

Working of Nuclear power Station:

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.
e)	**Explain how nuclear waste is disposed.**
Ans:	➢ **Nuclear waste disposal in nuclear power station** 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 is not carefully disposed off. ➢ **Solid Waste Disposal:-** ..... **(1.5 Mark)** Solid wastes are diluted to a sufficient level before disposed off. These can be disposed as below: The solid waste is buried deeply in the ground by making trench, However, the area must be away from populated area and there is less rain fall in that area. **OR** Solid waste is filled in a sealed container and it is disposed in sea-several Km away from sea-shore. **OR** Many times old and unused coalmines salt mines, can be used for waste disposal ➢ **Liquid Waste Disposal:-** ..... **(1.5 Mark)** The liquid waste is diluted to a sufficient level with large quantity of water and then released in the ground. However land should be unused and it should be away from populated area. **OR** The liquid waste after dilution is sealed in container and is disposal off into the sea several Km away from sea-shore.

	➢ **Gaseous Waste Disposal:-** ..... **(1 Mark)** Gaseous waste are generally diluted with air and passed through filter then released to atmosphere at high level through large height chimney
f)	**State any four advantages and four disadvantages of diesel electric power plant.**
Ans:	**Advantages of Diesel electric power plant**:- **(Any Four Advantages are Expected: 1/2 Mark each, Total: 2 Mark)** **Advantages of Diesel electric power plant:-** 1) The design and layout of Diesel electric P.P is simple. 2) It requires less space. 3) Time required for complete erection of diesel power plant is less. 4) Such plants can be located at any place. 5) The plants can be easily located nearer to load center. 6) It requires less space for fuel storage. 7) It is free from ash handling problem. 8) It requires less quantity of water for cooling. 9) It can be put into service immediately. 10) The plants can be put on load easily. 11) No standby losses. 12) Thermal efficiency of plant is higher than T.P.P. 13) Power plant is simple in operation. 14) It requires less operating & supervising staff. 15) Such power plant gives quickly responses for variable load 16) The size of diesel engine plant is small compared to the steam plant for the same capacity of generation. **Disadvantages of Diesel electric power plant:-** **(Any Four disadvantages are Expected: 1/2 Mark each, Total: 2 Mark)** 1) Operating cost is high as fuel (diesel) used is costly. 2) The cost of lubricating oil is high. 3) Maintenance cost is high.

	4) Diesel electrical power plant, generating capacity is limited. 5) Its overload capacity is less. 6) Diesel power plant can be not supply overload continuously. 7) Due to production of smoke there will be air pollution. 8) It produces noise from the exhaust which is a problem. 9) A useful life is very short. 10) Availability of fuel in future may be limited.
Q.4	**Attempt any FOUR of the following : 16 Marks**
a)	**Write any four salient features of a turbo alternator.**
Ans:	**Following are the salient features of a turbo alternator:** **(Any Four Features are expected: 1 Mark each)** ➢ It is 3-ph alternator. ➢ It is robust in construction. ➢ A separate excitation is given to separate alternator pole by DC generator (Exciter) which is mounted on same shaft. It excites the field winding of alternator. (Excitation voltage is 150-230V DC. Generally compound DC generator is used. ➢ To excite the main exciter there is pilot exciter which is of permanent magnet. ➢ The excitation voltage DC ➢ Generated voltage is 3.3KV, 6.6Kv, 11KV, 17.5KV or 20 KV. ➢ Number of poles 2 or 4: Its synchronous speed is 3000 rpm for two pole and 1500 rpm to 4 poles to get 50 Hz supply frequency ➢ They are smaller in diameter and of long axial length (diameter maximum 1 meter for 2 pole alternator) ➢ In case of alternator coupled with impulse turbine are horizontal shaft ➢ In case of alternator couple with reaction turbine is vertical shaft ➢ Steam turbine is high speed machine compare to the water turbine. ➢ Cooling system: for small rating alternators up to 40 MW. Stator and rotor is air cooled. ➢ For high rating alternator up to 150 MW, it is hydrogen cooled Above 150 MW hollow stator conductors is used through which coolant is circulated cooling

purpose. Cooling is necessary to improve the performance of alternator.

- Standard rating of turbo alternator are 125,200,250,300,500 MW maximum rating of turbo alternator is 500 MW.
- Protection **:**
  1. Protection against run away (high speed) speeds are provided
  2. Over voltage under voltage protection,
  3. Over load protection
  4. Over & under frequency protection,
  5. Over temperature protection are main protections provided to alternator
- Power factor is 0.8 lagging,
- Better in dynamic balancing

b) Write any four merits and four demerits of a thermal power plant.

Ans:

Merits of Thermal Power Plant-

(Any Four Merits are Expected: 1/2 Mark each, Total: 2 Mark)

1. **Cost of fuel:-**
   Fuel used in thermal power station (TPS) is cheaper than cost of fuel used in diesel & nuclear power station.
2. **Capital cost:-**
   Capital cost of TPS is less than hydro & nuclear power station.
3. **Near load center:-**
   TPS can be located near load center. The coal can be transport from coal mines to power plant. As it is located load centre it reduces transmission cost and losses in it.
4. **Space required:-**
   Less space required as compared to hydro power station.
5. **Generating cost:-**
   TPS can be built/construct of high generating capacity.
6. **Generating capacity:-**
   TPP can be build/construct of high generating capacity, so used as a base load power plant

7. Overload capacity:-

Steam engines and turbine can work under 25% overloads continuously.

8. Time required for completion of project:-

Time required for completion of TPP project is very less as compare to hydro power station.

Demerits of Thermal Power Plant-

(Any Four demerits are Expected: 1/2 Mark each, Total: 2 Mark)

1. Air pollution:-

It produces air pollution due to smoke and ash produced during combustion of fuel.

2. Starting Time:-

TPP cannot be put into service immediately like HPP. As thermal power plant required few hours (6-7 hour) to generate steam at high pressure and high temperature.

3. Handling of fuel:-

Handling of coal and disposal of ash is quite difficult.

4. Fuel transportation cost:-

When power plant are located away from coal mines i.e. near load centre at that time fuel transportation cost is more.

5. Preparation for fuel:-

There is more expenditure for preparation of coal (raw coal to pulverized coal)

6. Space required:-

Large amount of space is required for storage of fuel and ash as compare to NPP..

7. Efficiency:-

It is less efficient power plant overall efficiency is maximum 30 %.

8. Stand by losses:-

Stand by losses are more as furnace is required to keep in operation even when there is no load.

	9. Maintenance cost:- High maintenance and operating cost because number of axillaries plant are required such as coal and ash handling plant, pulverizing plant, condensing plant and water purification plant etc. **10. Availability of fuel:-** Less availability of high grade coal. **11. Simplicity and cleanness:-** Layout of thermal power plant is complicated than HPP due to coal and ash **12. Life:-** Life of TPP is less than HPP **13. Cost per unit (cost of generation)- High**
c)	**State any four advantages and four disadvantages of hydroelectric power plant.**
Ans:	➢ **Advantages of Hydroelectric power plant:- (Expected Any four Advantages)** **(Any Four Expected: 1/2 Mark to each point:2 Mark)** 1) There is no fuel cost as water is available in nature. 2) There is no fuel transportation cost. 3) There is no necessity of fuel & ash handling equipment. 4) There is no air pollution. 5) It is very neat & clean plant. 6) Operating & maintenance cost are very low. 7) H.P.P can be put into service immediately. 8) There are no standby losses. 9) Efficiency of plant is highest and does not change with age. 10) Power generation can be controlled quickly & rapidly without any difficult. 11) This plant is suitable for supplying power to variable load. 12) By controlling discharge of water precisely, constant speed & frequency can be maintained. 13) The life of plant is longest. 14) Generation cost per unit (KWH) is lowest. 15) In addition to generation of electric energy H.P.P. is also useful for supply of drinking water, supply of water for irrigation and control the flood.

	➢ **Disadvantages of hydroelectric Power Stations:-** **(Any Four Expected: 1/2 Mark to each point:2 Mark)** 1. High capital cost due to construction of dam. 2. It depends on nature as it require huge amount of water which is store during rainy season. 3. Firm power (Output) is totally depends on monsoon. 4. It takes long time for complete erecting of power plant. 5. It requires large area (catchment) area for storage of water. 6. As sites are away from load centre, so cost of transmission and losses in it are more. 7. There is limitation to select the site of HPP because of their requirements.
d)	**Explain fuel system in diesel electric power plant.**
Ans:	**Engine Fuel system:** **(4 Mark)** It supplies fuel to engine for combustion purpose. It consists of. ➢ Fuel Pump: - It supplies fuel to engine for combustion purpose. ➢ Strainer: - Are provided to remove suspended impurities and to supply clean fuel to engine. ➢ Fuel Injector: - It injects fuel in engine cylinder at the end of compression stroke. ➢ Heaters: - Are provided to heat the coil especially during winter season **OR** **Fuel supply system:** This system consists of fuel tank to store fuel, and fuel pumps and filters to transfer and inject fuel into the diesel engine. Fuel oil is supplied by trucks, rail, cars, etc. at the plant site.
e)	**Explain starting system in diesel electric power plant.**
Ans:	**Explanation of starting system in diesel electric power plant:** **(4 Mark)** ➢ This system is provided to rotate the engine initially until the firing starts and engine run under its own power. ➢ Different ways of starting are as below: • For small engine it is started manually by handle OR • By use battery operated electric motor. • For large diesel engine started by use of compressed air

OR

- Starting system is essential for the initial starting of engine.
- It consists of compressor, battery, and electric motor (or) self-starter.

f) Define each of following terms :
i) Plant capacity factor ii) Plant use factor iii) Diversity factor iv) Load factor.

Ans:

i) Plant capacity factor **(1 Mark)**

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

Plant capacity factor

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

ii) Plant use factor : **(1 Mark)**

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

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

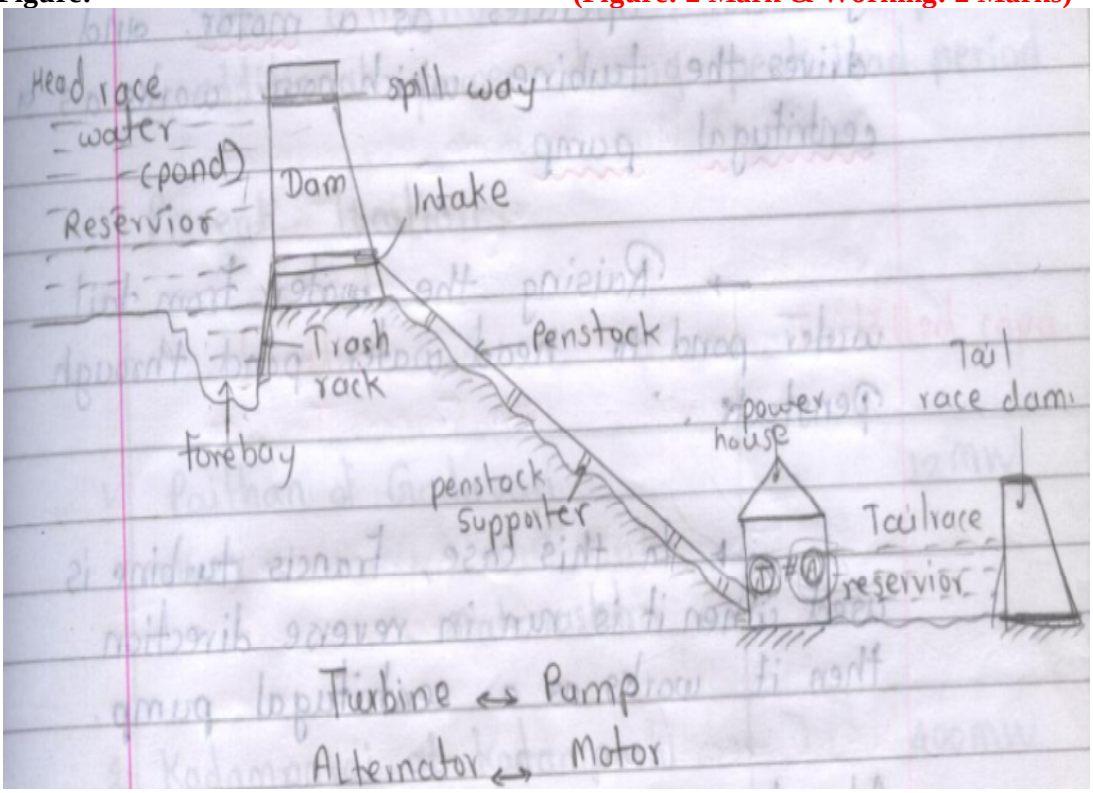
The ratio of the sum of the individual consumers, maximum demand to the maximum demand on power station

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

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

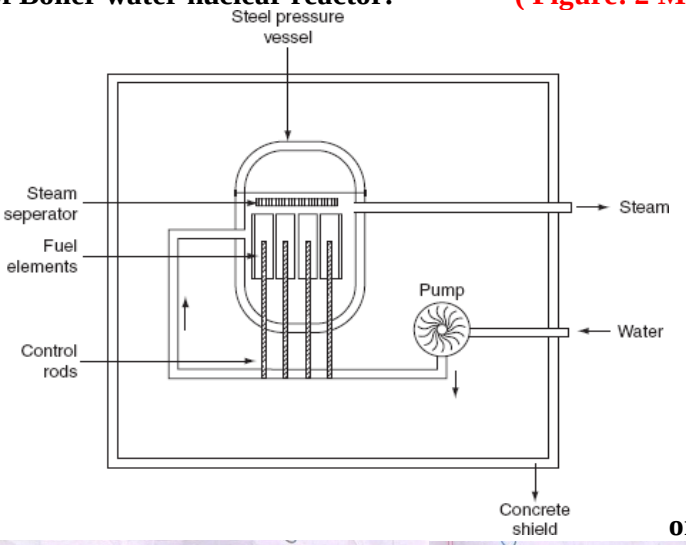
It is the ratio of average load to maximum demand during given period is known as Load Factor. **OR**

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

	Daily Load Factor $= \dfrac{\text{Number units generated in 1 Day}}{\text{Number of hours in a day (24 hours)} \times \text{M.D.}}$ **OR** **Monthly Load Factor** $= \dfrac{\text{Number of units generated (KWH) in month}}{\text{Number of hours in a month} \times \text{Maximum Demand}}$
Q.5	**Attempt any four of the following :** **16 Marks**
a)	**Explain working of pumped storage hydroelectric power plant.**
Ans:	**Figure:** **(Figure: 2 Mark & Working: 2 Marks)**  **or equivalent figure** **Explanation working of Pumped storage hydroelectric power plant :-** ➢ It consists of head water pond (reservoir) and tail water pond by constructing a dam at tail race path. ➢ Tail water pond and head water pond connected through penstock. ➢ During peak hours the turbine drives the generator and generates electrical energy.

	➢ The excess energy generated by steam and nuclear plants during the off-peak load is utilized to drive the motors in the pumped storage plants ➢ During OFF peak hours the generator operates as a motor. And drives the turbine which now works as centrifugal pump. ➢ Raising the water from tail water pond to head water pond through penstock. ➢ Such plants can be operated only in interconnected system, where other generating plants (such as TPP & NPP) are available during their off load period. ➢ In this case, Francis turbine is used.
b)	**Explain how nuclear reactor is controlled using control rods.**
Ans:	**Nuclear reactor is controlled using control rods:** **(4 Marks)** ➢ Control rods are made up of very high neutron absorbing material like boron, cadmium. ➢ By adjusting height of control rods on reactor core according to requirements we can control the chain reaction. ➢ When control rods are pushed in deep in core then control rod are absorb almost all neutron in the fission process. Hence chain reaction will stop automatically. ➢ However, when control rods are being withdrawn than more and more neutrons cause fission process and hence intensity of chain reaction (heat produced) will increase. ➢ Therefore by putting out of control rods power of nuclear reaction will increase. Whereas by pushing control rod it will reduce. **OR** ➢ By adjusting height of control rods in reactor core according to requirement we can control the chain reaction. ➢ When control rods are pushed deep in the core then it absorbs all neutrons from the fission process. Hence chain reaction will stop automatically. ➢ However, when control rods are being withdrawn then more & more neutrons causes fission process & hence intensity of chain reaction(heat produced) will increased. ➢ Therefore pulling out of control rods from the core, power of nuclear reaction will increase. Whereas by pushing control rod towards the core it will reduce.

c)	**Explain working of boiler water nuclear reactor.**
Ans:	**Figure of Boiler water nuclear reactor:** **(Figure: 2 Mark & Working : 2 Mark)**



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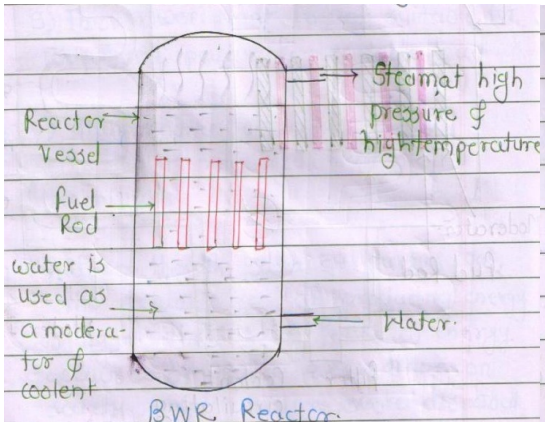
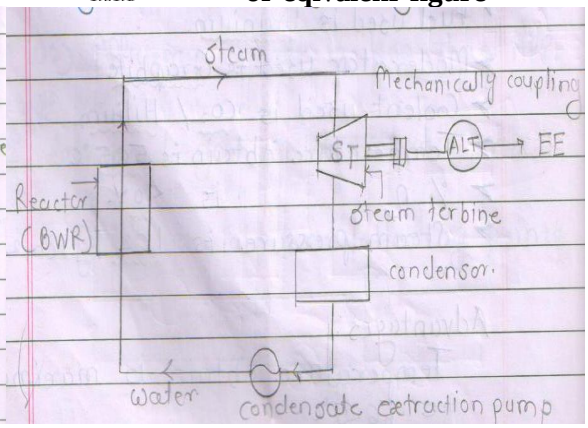


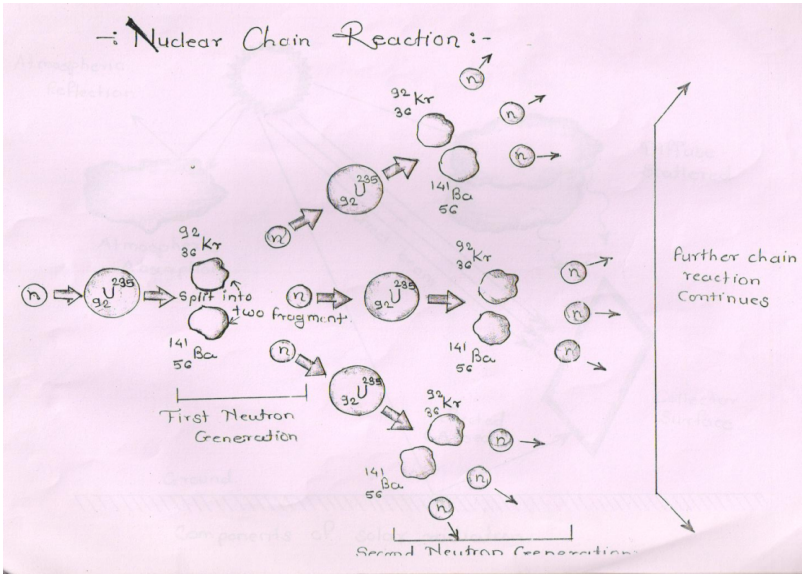


Explanation of working Boiler water nuclear reactor:

- In BWR the steam is generated in the reactor itself. There is no need of heat exchanger.
- Fuel used is Enriched Uranium.
- Moderator used is light or heavy water.
- Coolant used is light or heavy water.
- Temperature obtain is 280^0C.
- Efficiency is 33 %.
- Steam pressure is 68 Kg/cm^2

d)	**Explain nuclear chain reaction and multiplying factor w.r.t. nuclear power plant.**

Ans: **Figure of Chain Reaction:** **(Figure:1 Mark & explanation:1 Mark, Total: 2 Marks)**



or eqivalenr figure

Explanation for Chain Reaction:

When nuclear fuel U^{235} or Pu^{239} when strikes by a slow neutron in nuclear reactor than it under goes nuclear reaction at that time ;

- Huge amount of heat energy is liberated and
- Two or three neutron are produced
- $\alpha, \beta, \& \gamma$ rays are produced
- Beryllium & krypton are also produced.

Due to two or three neutron chain reaction is continuous till most of the original nuclei in the given sample are fissioned is called as chain reaction.

A chain reaction will continue till most of the original nucleus in the given sample is fission out.

Multiplication factor (k)- ……..……...(2 Mark)

- At the time of starting chain reaction, value of multiplication factor (k) should be kept greater than one.
- At the time of steady condition chain reaction, value of multiplication factor

(k) should be kept equal to one.

- At the time of shutting down chain reaction, value of multiplication factor (k) should be kept less than one.
- In this way nuclear reactor is controlled.

OR

$$\text{Multiplication factor (k)} = \frac{\text{Number of neutrons on any one generating stage during fission process}}{\text{Number of neutrons of premediately preceding generation during fission process}}$$

e) State any four limitations in using renewable energy resources.

Ans:

Following are the Limitations of renewable energy resources

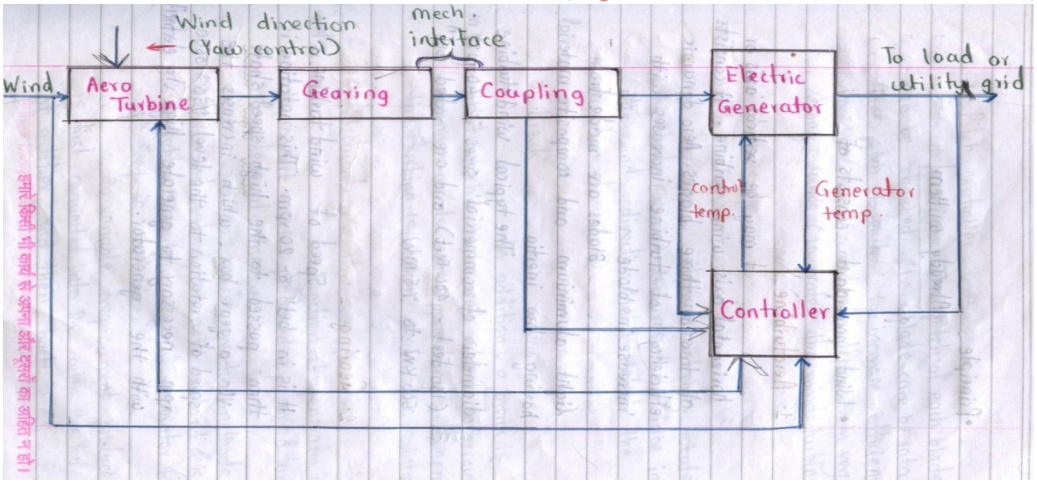
(Any four points are expected: 1 Mark each)

1. Initial cost per MW is high.
2. The source of power is unsteady and unreliable.
3. No firm generating capacity.
5. It's efficiency is low (20% -30%).
6. There is limitation on site selection.

OR

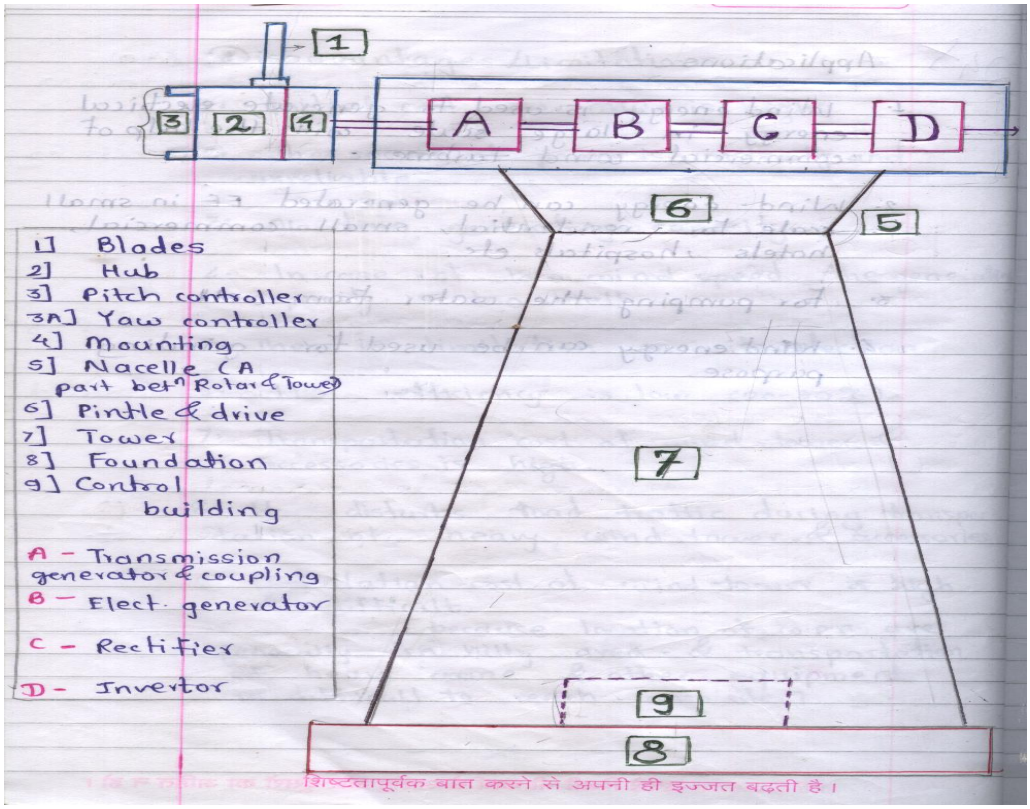
1. Capital cost per MW of power plant is more.
2. Its reliability is less.
3. No firm power.
4. Its efficiency is less.
5. Generally, its generating capacity is limited.
6. Technology to generate electricity from renewable sources is not fully developed.
7. There is limitation on site selection.
8. There is no guaranty that power is generated during peak hours or whenever needed.
9. Power generation is not phase with demand.
10. Cost per unit is high in some power plant.

f)	**Draw block diagram of wind power/energy conversion system. Write function of each block.**
Ans:	**Block diagram of wind power conversion system:-** **(Figure- 2 Mark & Function-2 Mark)**



OR

Equivalent Figure



OR Equivalent Figure

Function of wind power/energy conversion system each parts:

(Any Two expected: 1 Mark each)

1) Rotor /Blade/Aero-turbine:

Blade extracts significant power from the wind. Which convert the force (K.E.) of the wind into the rotary motion to generate useful mechanical power. **OR**

Rotor blades: The blades are the sails of the system, when the wind forces the blades to move, it has transferred some of its energy to the rotor.

2) Hub:

Hub of the wind turbine is that component which connects the blade to the main shaft and altimately to the rest of drive train.Hubs are generally made up of steel.

3) Main Shaft (Low speed shaft):

- It is provided for transfer of torque from the rotor blade to the rest of the drive train. It also supports weight of rotor.
- Speed of the shaft is low, is about 30 to 60 rotations per unit.

4) High speed shaft:

- It is connected to generator via-gearbox,
- Speed of the wind turbine is low; gearing arrangement increases the speed of rotation to the level as per design. e.g. 1500 rpm for 50 Hz frequency and 1800 rpm for 60 Hz frequency necessary to generate electricity with the help of generator.
- Gear box is one of the heaviest and most expensive component in wind turbine.

5) Coupling:

Coupling are used to connect shaft together

- Between main shaft and gear box
- Between gear box output and the generator.

6) Break:

- The break is fitted to stop the wind turbine. By applying break
- When dangerously strong wind are approaching i.e. when wind speed exceeds 55-65 miles per hour to avoid damage **OR**
- In case of emergency to stop the rotation of turbine **OR**

- When the turbine is taken down for maintenance.

7) Yaw Controller:

- It rotates the blade towards the face into the wind direction i.e. it detects the direction of wind. **OR**
- Yaw system: they perform the task of orienting the rotor in the direction of wind.

8) Pitch Controller:

- The pitch controller adjust automatically the pitch of each blade
- i.e. blade can be rotate to increases efficiency in low wind
- and to decrease in very strong winds (to protect the wind turbine)

9) Electrical Generator:

Function of generator is to convert mechanical energy produced by wind turbine into electrical energy.

10) Anemometer:

It's a wind direction sensor with digital display. Used in areas where AC power is not available. Monitors wind speed and store max and average value.

11) Controller:

Controller takes data from anemometer (which measures the wind velocity): The controller sends:

- Wind direction & wind speed
- The controller protect wind turbine from abnormal wind conditions, excessive temperature rise of generator, electrical fault etc.

12) Nacelle:

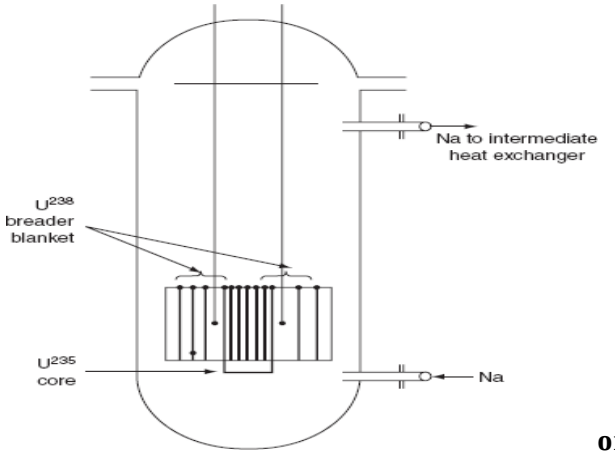
- Necelle cover provides weather protection for the principle components of the wind turbine. **OR**
- Nacelle: It is structure that houses all of the generating components like-gearbox, rotor shaft and brake assembly etc.

13) Tower:

- A tower is needed to elevate the blades to where the wind is stronger and smoother
- Towers are supports to raise the main part of the turbine up in the air.

Q.6	**Attempt any Four of the following :**	**16 Marks**
a)	**Explain working of fast breeder reactor.**	

Ans: **Block Diagram of fast breeder reactor:** **(Figure: 2 Mark & Working: 2 Mark)**



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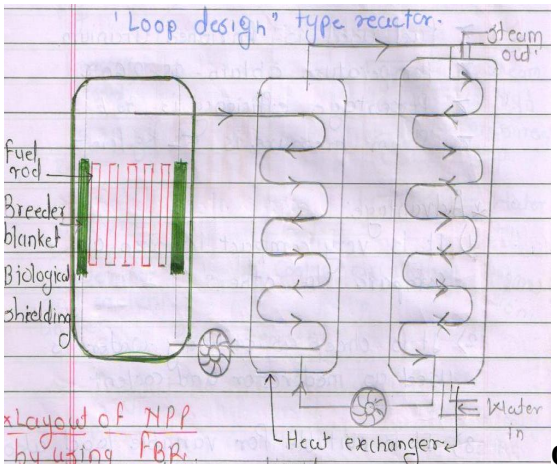

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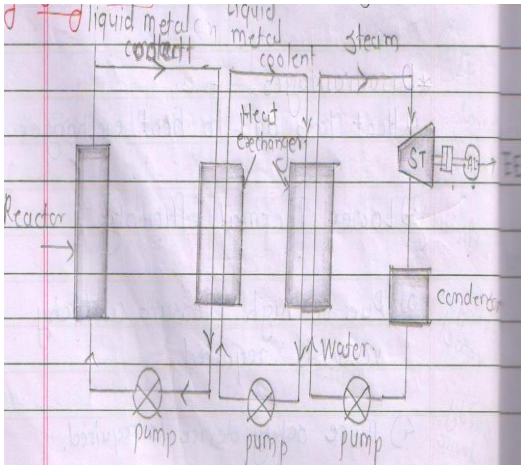


It is explanation working of on following points:

- Fuel used is natural or Enriched Uranium and the core region is also surrounding by a blanket of breeder (fertile) material (U^{238} or Th^{232}).
- The fertile material absorbs neutrons produced by chain reaction and thus produces fissile material (Pu^{238} or U^{233}) which are fissile material.
- A true breeder reactor produces more new fuel than it consumes.
- The term **"fast"** comes from the fact that the majority of the fission events are caused by fast neutrons, rather than slow or thermal neutrons. In fact no moderator is present at

	all to slow down the fast neutrons. No Moderator is used. ➢ Coolant used is sodium or potassium liquid metal. ➢ Temperature obtain is 537^0C. ➢ Efficiency is 43 %. ➢ Steam pressure is 162 Kg/cm^2 ➢ In this type of reactor two heat exchanger are used (to avoid the possibility by sodium water reaction with the radioactive sodium.) ➢ This type of reactor is also called as liquid metal cooled fast breeder reactor (LMFBR), there are two types of design 1) Pool design and 2) Loop-design
b)	**A plant having load factor of 0.6 has peak load of 110 MW. Calculate energy generated by this plant in one month of 30 days.**
Ans:	$Number of\ units\ generated = Maximum\ demand \times Load\ factor \times No.\ of\ hours\ for\ month$ **--(2 Mark)** $Number\ of\ units\ generated = 110 \times 10^3 \times 0.6 \times (30 \times 24)$ $Number of\ units\ generated = 574992000\ KWH$ ----------**(2 Mark)**
c)	**State any four advantages of interconnected power plants.**
Ans:	**Advantages of interconnected Systems:** **(Any Four points expected each point 1 Mark, Total : 4 Mark)** **i) Reduced Overall installed Capacity:-** Inter connected power systems reduce the overall requirement of installed capacity. With interconnection between power systems, peak demand in an area is meet by importing power from neighboring area. Thus, it also reduces investment and fulfills the peak demand. **ii) Better Utilization Hydro Power:-** In combined power system, hydro power can be utilized in more effective way. during rainy season, hydro power plant can be utilized, while during draught periods, steam power plant can be used as base load plant.

iii) Reliability of Supply:-

The reliability of steam power plants depends upon the coal supply and that of hydro power plant depends upon the stream flow. due to greater diversity, a combined operation of various types of power plant is more reliable than individual power plant.

iv) High unit size possible:-

Generating units of higher unit capacity (200MW, 500MW etc) can be installed and operated economically.

v) Improved quality of voltage and frequency:-

Isolated power systems have higher frequency fluctuations with change in load. With inter connections, the system becomes stronger & the effect of load is reduced.

vi) Exchange of peak loads:-

If the load curve of power station shows a peak demand that is greater than the rated capacity of the plant, then the excess load can be shared by other stations connected with it.

vii) Use of older Plants:-

The interconnected system makes it possible to use older and less efficient plants to carry peak loads of short durations. Although such plants may be inadequate when used alone, yet they have sufficient capacity to carry short peaks up load when inter-connected with other modern plants.

viii) Insure Economical operation:-

The interconnected system makes the operation of concerned power station quite economical. It is because sharing of loads among the stations is arranged in such a way that more efficient plants work for peak load hours only.

ix) Increases Diversity factor:-

The maximum demand on the system is reduced because load curves of different inter-connected stations are different. So, diversity factor of the system is improved, thereby increasing the effective capacity of the system.

x) Increases load factor:-

The load factor and efficiency of operation are improved.

xi) Reduces Plant Reserve capacity:-

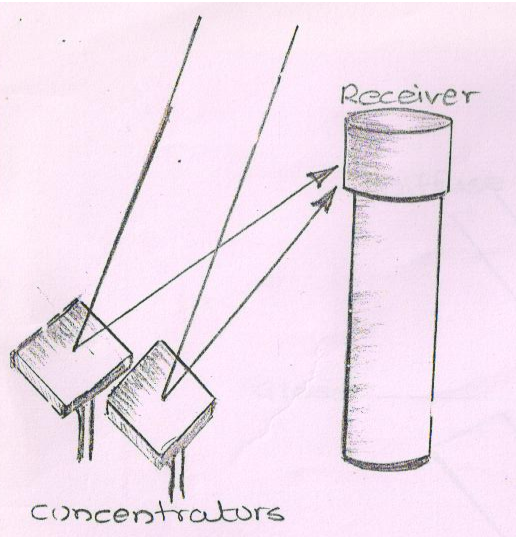
Every power station is required to have a standby unit for emergencies. However when several power stations are connected in parallel, the reserve capacity of the system is mush reduced. This increases efficiency of the system.

xii) Better utilization of natural resources:

Due to interconnection, there is optimum utilization of available natural resources in the country is possible.

d) Explain working of concentrating type of solar collector.

Ans: **Figure concentrating type of solar collector: (Figure: 2 Mark & Working: 2 Mark)**



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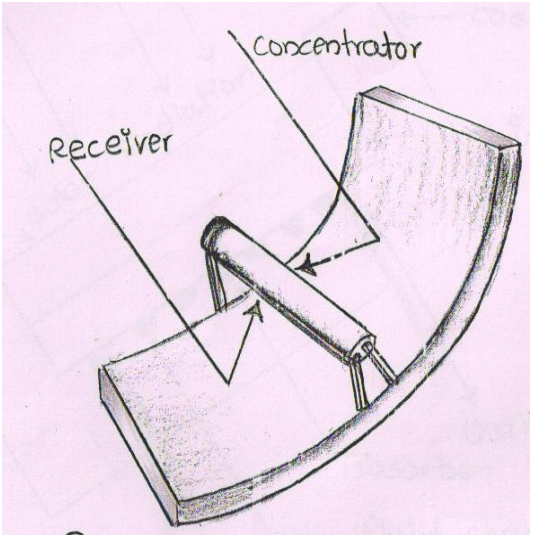


All concentrating solar thermal power (STP) technologies rely on four basic key elements:

- Concentrator,
- Receiver,
- Transport-storage,
- Steam generator (Heat exchanger)
- Condenser
- Steam turbine
- Alternator and

Working of Concentrating type of Solar collector:

- The concentrator captures and concentrates solar radiation,
- This is then delivered to the receiver.
- The receiver absorbs the concentrated sunlight,
- Transferring its heat energy to a working fluid.(As good as coolant) This coolant is

re-circulated again and again

- The transport-storage system passes the fluid from the receiver to the heat exchanger where steam at high temperature and high pressure generated.

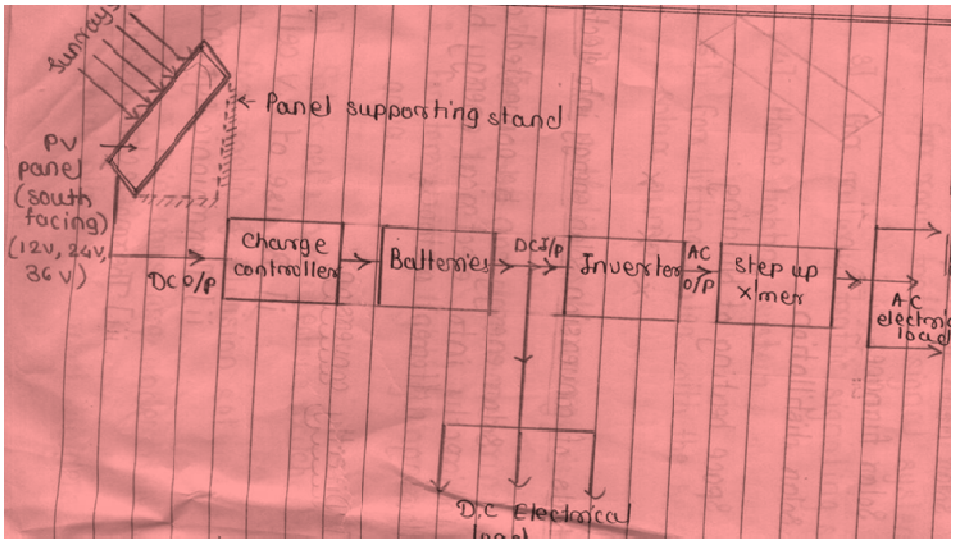
OR

- It consists of cylindrical parabolic concentrator and through reflector have been made of highly polished aluminum or silver glass or thin film of aluminized plastic or mirrors on a film base.
- And absorber which is well insulated is placed along focus axis.
- In this type solar collector, radiation is collected over the area of the reflecting surface and is concentrated at the focus of the parabola (absorber)
- Tracking of collector according to sun direction is necessary for better result.
- The tracking is always from south to north direction because there is more solar energy in this direction than the East-West arrangement.

e) Explain working of solar power plant.

Ans:

Schematic diagram of solar power plant: (Figure: 2 Mark & Working: 2 Mark)



or equivalent figure.

Working of solar power plant:

Solar cell operates on principle of Photo-voltaic effect which is process of generating an emf (DC) when it absorbs sun radiations

OR

	Working of solar power plant: 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 convert DC supply into AC supply.. **5. Step-up transformer:** It step-up input voltage to utilization voltage e.g. 230V
f)	**Write how energy can be stored or generated in each of following :** **i) solar cell ii) geothermal energy iii) hydrogen energy in biomass.**
Ans:	**i) Solar cell :** **(1.5 Mark)** **Energy can be stored:** 1. Storage Battery is used to store electricity. **OR** **Energy can be generated** 1. Directly Conversion: a) By use of P.V Cell (photovoltaic cell) b) Thermo ionic system conversion c) Thermoelectric (see beck effect) 2. Indirectly Conversion**:** a) Solar thermal power plant

ii) Geothermal energy: **(1.5 Mark)**

Energy can be stored:

1. The -storage transport system. **OR**

Energy can be generated

1. Hydrothermal convective systems:
   a) Dry Steam geothermal power Generation:-
   b) Wet Steam geothermal power Generation:-
   c) Hot water fields
2. Geo-pressure resources:
3. Hot dry rocks (HDR)
4. Magma resources
5. Volcanoes

iii) hydrogen energy in biomass: **(1 Mark)**

1. Gas generated is stored in gas chamber (Dome) **OR**

Energy can be generated

1. The biomass such as wood, dung and agricultural residues is burnt directly to obtain energy :-
2. The biomass is converted to fuels such as ethanol and methanol, which can be used as liquid fuels in engines:-
3. The biomass is subjected to fermentation process to obtain a gaseous fuel called biomass

----------**END**----------