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 the different types of fuels with two example of each.**

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

Following types of fuels:

1. Solid Fuel : Coal, U^{235}
2. Liquid fuel: Diesel, Petrol and water
3. Gases: Natural gas, gas and Biogas

OR

	Types of fuels
A	**BIOMASS**
1	Wood
2	Cattle dung
3	**Bagasse**
4	Wheat and rice straw
5	Cane trash, rice husk, leaves and vegetable wastes
6	Coconut husks, dry grass and crop residues
7	Groundnut shells
8	Coffee and oil palm husks
9	Cotton husks
10	Peat
B	FOSSIL FUELS
1	Coal

2	Coke
3	Charcoal
4	Carbon
5	Fuel oil
6	Kerosene and diesel
7	**Petrol**
8	Paraffin
9	**Natural gas**
10	Coal gas
11	Electrical (Kcal(KW)
12	Bio gas(Kcal/cu mtr) (12 kg of dung produces 1 cu. Mtr gas)

OR

1. Water or Hydro
2. Fuel used as a high grade coal,
3. Fuel used as a natural oil and gas
4. Fuel used as a diesel
5. Atomic or Nuclear Energy

OR

i) The sun energy

ii) The wind energy

iii) Geothermal Energy

iv) Ocean Tides, Waves or thermal energy

v) Biomass energy

b) Name any two thermal power stations in Maharashtra with their installed capacity.

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) State the different types of condensers used in thermal power station.

Ans:

Types of condenser: **(2 Marks)**

1. Jet Condenser 2. Surface condenser

d) Define penstock in Hydroelectric Plant.

Ans:

Meaning of Penstock in Hydroelectric Plant: **(2 Marks)**

- It is a conduit pipeline. It function is to carry water from the water intake (reservoir) to turbine.

e) Give the types of hydro power plant on the basis of availability of water head.

Ans:

Hydro power plants are classified according to head of water as below: **(2 Marks)**

i) Low head power plant (Below 30m)

ii) Medium head power plant (30 to 300 m)

iii) High head power plant (above 300m)

f) State the purpose of reflector in a nuclear power plant.

Ans:

The purpose of reflection in a nuclear plant: **(2 Marks)**

The purpose of reflector is to reflect escaping neutron from chain reaction.

g) Give four properties of a good moderator for nuclear reaction control.

Ans: **(2 Marks)**

A good moderator material should have following prorperties:

1. Low neutron absorption
2. It should have high scattering cross-section.

	3. It must not react with neutrons. Neutrons captured in nuclear reactions are lost to the fission process, so that the reactor becomes inefficient. 4. It should not be very costly. 5. It must be non-corrosive. 6. Chemical and radiation stability. 7. High-thermal conductivity.
h)	**List the main parts of a diesel electric power plant.**
Ans:	**Main Parts of diesel electric plants:** **(Any Four expected 1/2 each, Total 2 Marks)** 1) Diesel Engine 2) Engine air intake system 3) Engine fuel System 4) Engine exhaust system 5) Engine cooling System 6) Engine Lubricating System 7) Engine starting system 8) Flywheel 9) Governor 10) Alternator **OR Student May write following ways** **Main Parts of diesel electric plants:** **(Any Four expected 1/2 each, Total 2 Marks)** 1) Air Filter 2) Supercharger (boosting) 3) Fuel Pump 4) Strainer 5) Fuel Injector 6) Heaters 7) Silencer 8) Muffler 9) Oil pump 10) Strainer & Filter

i) Define cold reserves and hot reserves of a power system.

Ans:

1) Cold reserves: **(1 Mark)**

It is stand by generating capacity which is available for service but not in operation.

2) Hot reserver: **(1 Mark)**

It is reserved generating capacity, in operation but not in service (not connected to bus bar/grid)

j) Define the load factor of a power plant.

Ans:

Load Factor:- **(2 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**

$$\textbf{Daily Load Factor} = \frac{\text{Number units generated in 1 Day}}{\text{Number of hours in a day (24 hours)} \times \text{M.D.}}$$ **OR**

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

OR

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

k) State location of any four nuclear plants in India.

Ans:

(Any Four Location are expected 1/2 each, Total 2 Marks)

S.No	Power Station	Location	District	State
1	Tarapur atomic PS	Tarapur	Thane	Maharashtra
2	Madras APS	Kalpakkam	Kancheepurm	Tamilnadu
3	Madras APS	Kalpakkam	kancheepurm	Tamilnadu
4	Kaiga NPP	Kaiga	Uttar kannada	Karnataka
5	Kakrapur APS	Kakrapur	Surat	Gujrat
6	Kudan kulam NPP	Kudan kulam	Tiruhelveli	Tamilnadu
7	Narara APS	Narara	Bulandshar	Uttar Pradesh
8	Pajushtan APS	Rawatbhata	chittorghar	Rajushtan

l)	**Give four applications of diesel power plant.**
Ans:	**Applications of Diesel Power Plant:** **(Any Four Application Expected:1/2 each)** 1) It can be used as a standby (emergency) power plant to maintain continuity of supply. 2) It is suitable where power requirement is small. 3) It is widely used in transportation system. E.g. Elect. Traction, Ship, Aero plane etc. 4) It is suitable as a peak load power plant for short duration. 5) Mobile DEPP mounted on vehicle is used in emergency requirement and for temporary 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. 8) The use of such plant is very common during construction stage of HPP/TPP/NPP and other construction. **OR** 1) The diesel units can be used to supply the auxiliaries for starting the large thermal plants. 2) It is used as a stand by unit. Incase failure of main supply like hospital, Telephone exchange Radio stations, Colleges, and cinema Theaters. 3) It can be used as a Peak load plant. 4) D.G. Set can be installed on mobile unit and It can be used for emergency or temporary purpose for supplying power for large exhibitions. 5) In remote areas where distribution of electricity is not possible at that time to supply power D.G. set are used. 6) It is widely used in transportation system for e.g. Electric traction, Ship etc. **OR** 1) Diesel plants are widely used for generating power ranging from 100 to 5,000 H.P. 2) Diesel plants can be used as standby plants for steam and hydropower plants. 3) These plants are used to supply peak-load plants. These plants are suitable for mobile power generation and widely used in ships, aeroplanes, automobiles, etc. These plants are preferred for industrial applications for which power requirement is small of the order of 500 kW.

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

a) **Compare conventional energy sources with non-conventional energy sources. (any four)**

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

S.No.	Points	Conventional energy	Nonconventional 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 is 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) **Write the purpose of coal and ash handling unit also write different activities that are carried out in this unit.**

Ans: **(Purpose -2 Marks Activities - 2 Marks)**

Purpose:

- A large quantity of coal is required as a fuel in furnace of boiler for combustion to produce heat energy for production of steam for this purpose coal handling unit is used
- 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/Activitives for coal handling :-**

1. coal delivery
2. coal unloading
3. coal storage:- a) outdoor storage (dead storage) b) Indoor storage (live storage)
4. In the plant coal is crushed into small pieces with the help of crusher and breaker. The coal is crushed to 2.5 cm. or less.
5. Than it is cleaned by passing forced air to remove the dust contain.
6. Than it is dewatered (remove of moisture) with the help of dryer. The moisture

content must be less than 2% after drying operation.

7. Then it is passed through magnetic separator to separate the iron particles mixed in it.
8. Then coal is passed to pulverizing mill.
9. Pulvarised Coal weighing
10. Pulvarised coal is than transfer into the boiler furnace

- **Steps for Ash handling :-**

Before handling the Ash it is desirable to quench the ash.

Handling of Ash includes :-

i) Removal of ash from furnace

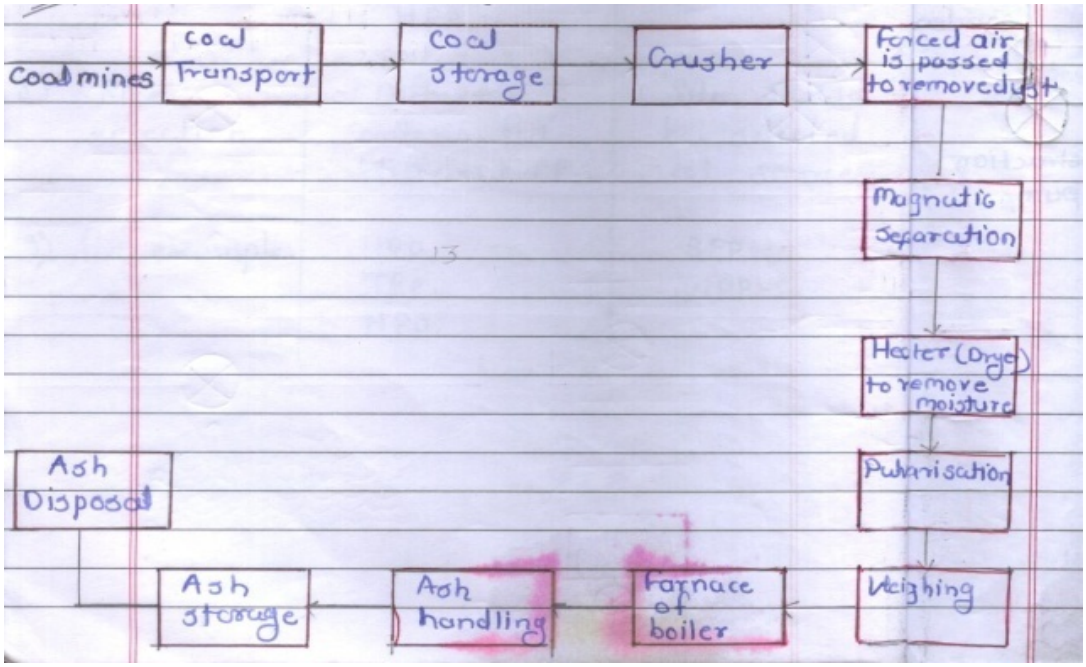
ii) Loading of ash on conveyers belt.

iii) And delivered to the space where it can be disposed off.

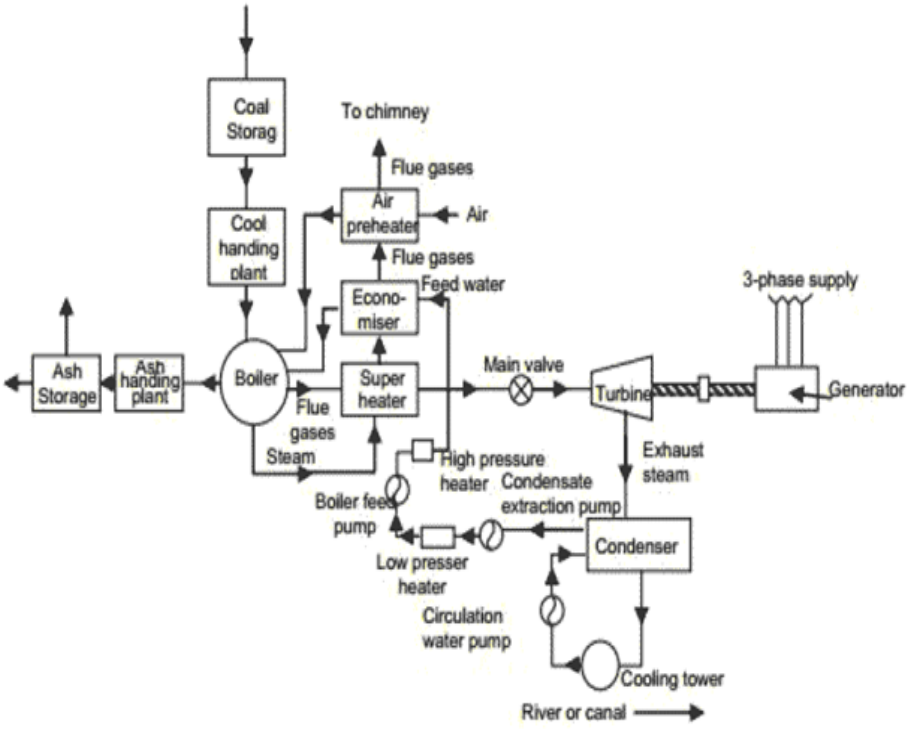
OR

(STUDENTS MAY DRAW FOLLOWING FLOW DIAGRAM)

Coal And Ash Cycle :-



c)	**Draw a neat layout of thermal power station and label it.**
Ans:	**Neat layout of thermal power station:** **(Figure: 2 Mark & Label it: 2 Mark)**



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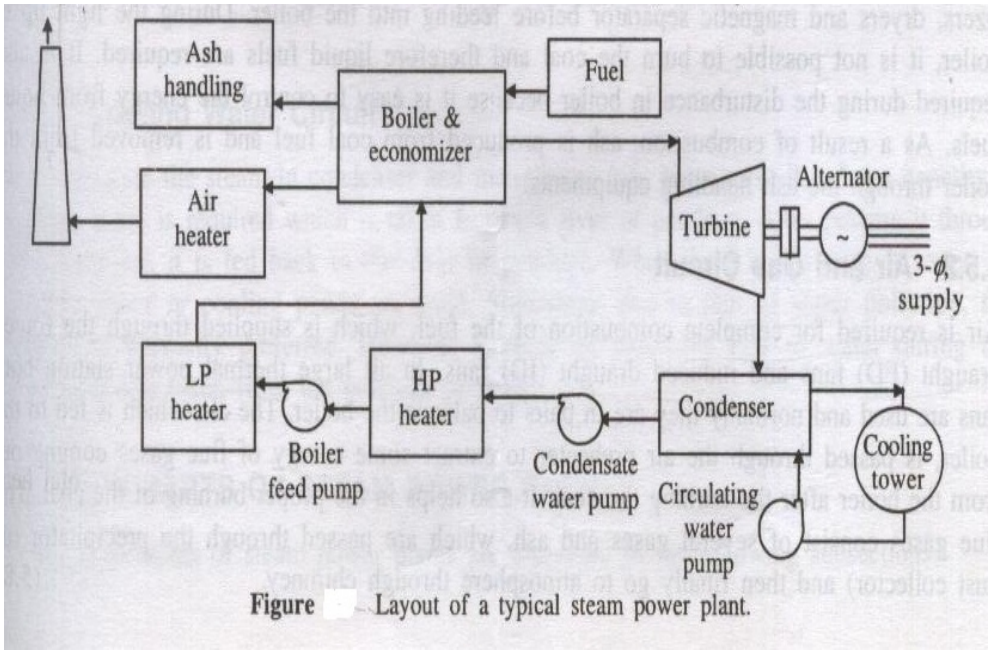


Figure Layout of a typical steam power plant.

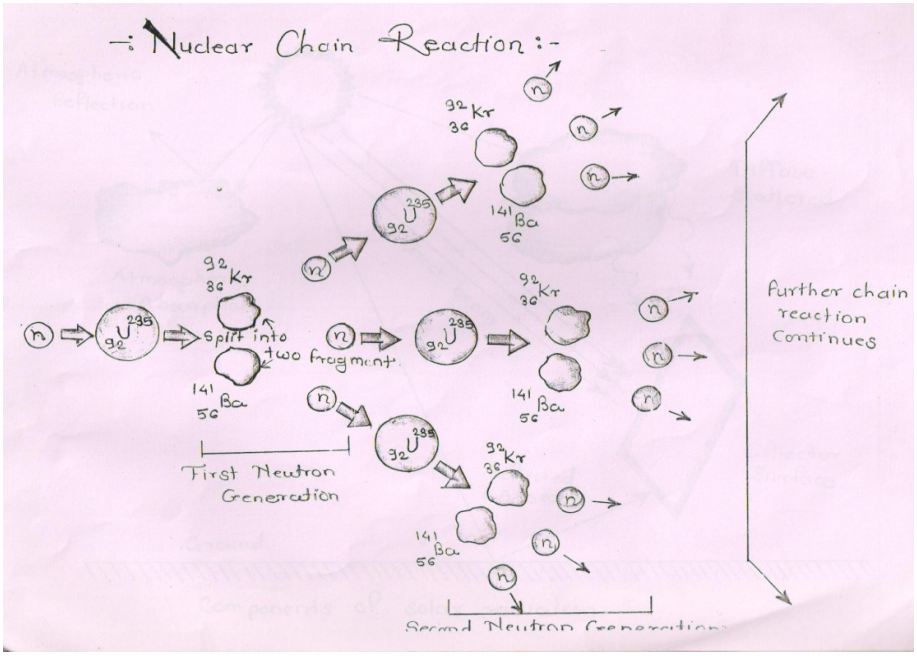
OR Equivalent Figure

d)	**Explain working of the pumped storage plants.**
Ans:	**(4 Marks)** **Pumped storage hydroelectric power plant & Operation:-** ➢ 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.
e)	**Explain why the overall efficiency of thermal power station is low. Suggest any four remedies improvement.**
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.** **(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.*) Also the average steam temperature should be as high as possible during heat addition and as low as possible during heat rejection.
f)	**State any six factors governing selection of site for thermal stations and explain each in brief.**
Ans:	Following factorss are considred while selecting site for thermal power station :- **(Any six points expected: for first two factors 1 Mark each & remaining four applications 1/2 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 eg. For 2000 MW capacity power plant requirement of coal is 20000 T/day. **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. For 2000 MW power plant around 200 to 250 acres land is require. Sufficient land must be available nearby the power station to build the residential accommodation to the operation and maintenance staff. **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.
Q.3	**Attempt any FOUR of the following : 16 Marks**
a)	**State the type of power plant preferred for peak load supply of power. Justify the selection.**
Ans:	**The type of power plant preferred for peak load supply of power: (2 Mark)** 1. Pumped storage hydro power plant 2. Low water storage hydro power plant 3. Gas power plant 4. Diesel power plant (In case of emergency only) because cost per unit is more **Above power plant fulfill the Following requirements which are suitable for supplying Peak load: (Any two points are expected: 2 Mark)** **1) Put into service immediately:** Power plant can be started immediately that is quick starting **2) Quick Response:** Power plant must show (give) quick response to load variation because peak loads is variable. **3) Capital, maintenance and Running cost:** As far as possible capital, maintenance, running cost should be low.

b)	**Explain the nuclear chain reaction in a nuclear power plant.**
Ans:	**Figure of Chain Reaction:** **(Figure:2 Mark & explanation:2 Mark, Total: 4 Marks)**



Explanation for Chain Reaction:

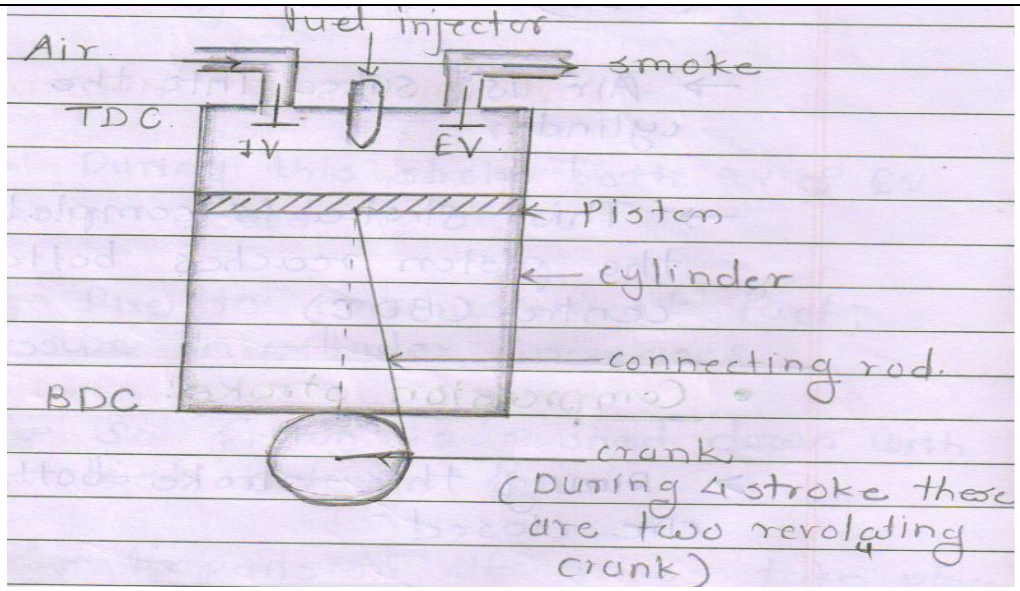
When nuclear fuel U^{235} or Pu^{239} when strikes by a slow neutron in nuclear reactor than it under goes nuclear reaction at that time ;

- 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.

c)	**Explain the working of two stroke diesel engine with the help of neat diagram.**
Ans:	**Neat Diagram of Two stroke Diesel Engine:** **(Figure:1 Mark & Explanation:3 Mark, Total: 4 Marks)**



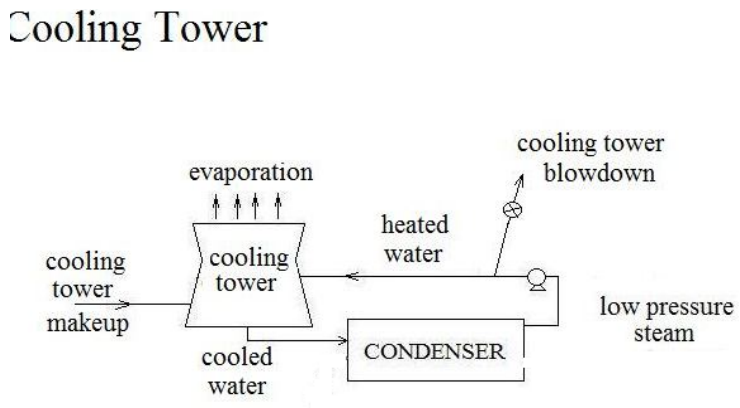
OR Equivalent figure

Working of Two Stroke Diesel Engine:

- In case of 2 stroke diesel engine all the 4 operations are completed with 2 strokes of the piston or during one revolution of the crank shaft.
- Intake and compression stroke are completed during the forward travel of piston.
- The power (expansion) and exhaust stoke are completed during the travel of the piston in backward direction.

d) Draw and explain the working of cooling tower in a thermal power station.

Ans: **(Figure:1 Mark & explanation:3 Mark, Total: 4 Marks)**



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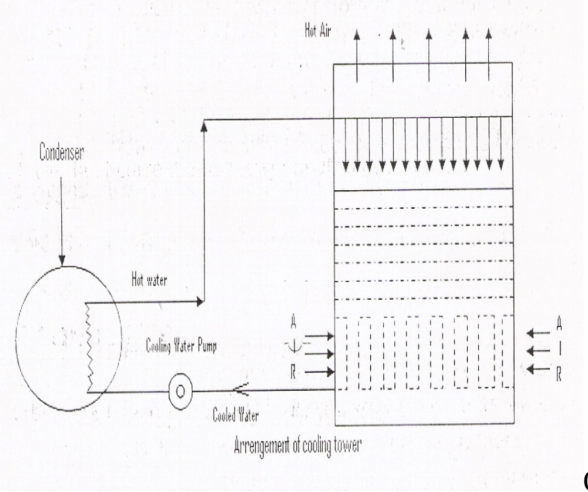

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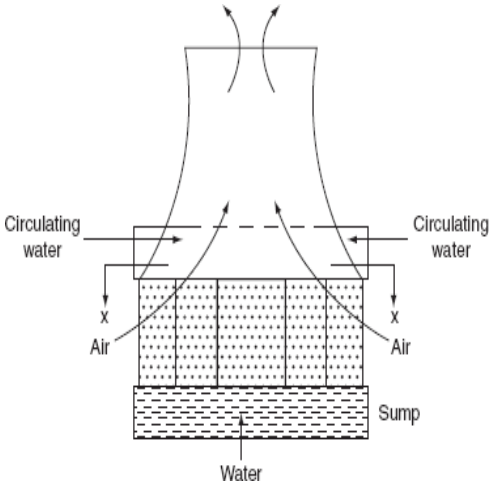


Explanation:

- **The function** of cooling tower is to reduce the temperature of water coming from condenser.
- A cooling tower is a steel or concrete hyperbolic structure. There is reservoir at the bottom for storing the cold water.
- Water is circulated from the basin of the cooling tower to the condenser. It absorbs latent heat from the steam and get warm.
- This warm water is return to the cooling tower to reduce the temperature.
- Hot water from condenser outlet is dropped from a height of about 8–10 m. The cooling tower reduces the temperature of the hot water by about 7°C–10°C, as it falls down into the basin at the bottom of the cooling tower.
- This water at the reduced temperature is recirculated through the condenser and the cycle is repeated.
- In cooling Tower temperature of water is reduced either by natural or forced or induced draught method or combine.

e) "Hydro electric power stations are not perennial power station" Justify the statement.

Ans: **(4 Marks)**

The water utilized by the hydro power plants comes mostly from storage dams/reservoirs which get filled up during the monsoon rainy season. Such reservoirs are utilized for supplying water to various purposes to:

e.g. 1) Water drinking storage

2) Agriculture/ irrigation purpose **and third** purpose is generation of electricity

Since rainfall is depends on nature which is fluctuating/ uneven so water available

	in reservoirs should be properly used. i.e. for purpose of : 1) Water drinking storage 2) Agriculture/ irrigation purpose and not for generation of electricity because first two purposes are important. Hence **"Hydro electric power stations are not perennial power station"**
f)	**State the types of radioactive waste generated in a nuclear power station. Explain the methods employed for their disposal.**
Ans:	**(Types :2 Mark & Explanation of Methods employed:2 Mark, Total: 4 Marks)** **The Types of radioactive Waste Generated in nuclear Power Station** 1. Solid Waste Disposal 2. Liquid Waste Disposal 3. Gaseous Waste Disposal **Following are the methods employed for their disposal:** ➢ **Solid Waste Disposal:-** 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:-** 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:-** Gaseous waste are generally diluted with air and passed through filter then released to atmosphere at high level through large height chimney. **OR** Spent fuel storage: ➢ The spent fuel assemblies removed from the reactor are very hot and radioactive. ➢ Therefore the spent fuel is stored under water, which provides both cooling and radiation shielding. ➢ After a few years, spent fuel can be transferred to an interim storage facility. ➢ This facility can involve either wet storage, where spent fuel is kept in water pools, or dry ➢ Storage, where spent fuel is kept in casks. ➢ Both the heat and radioactivity decrease over time. ➢ After 40 years in storage, the fuel's radioactivity will be about a thousand times lower than when it was removed from the reactor) Spent fuel and HIGH level waste disposal ➢ Spent nuclear fuel or high level waste can be safely disposed of deep underground, in ➢ Stable rock formations such as granite, thus eliminating the health risk to people and the environment. ➢ The first disposal facilities will be in operation around 2020. ➢ Waste will be packed in long-lasting containers and buried deep in the geological formations chosen for their favorable stability and geochemistry, including limited water movement. ➢ These geological formations have stability over hundreds of millions of years, far longer than the waste is dangerous.
Q.4	**Attempt any FOUR of the following : 16 Marks**
a)	**Explain the purpose of surge of tank and spillway in hydro electric power station.**
Ans:	**1. Surge Tank:-** **(2 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.

2. Spillways: - **(2 Mark)**

- During floods, there will be excess water store in reservoir, which creates more pressure on dam which is not favorable as far as dam design is concern.
- It acts as a safety value for a dam. It discharges excess water when head of water increases above predetermine maximum level, at the time of heavy rainfall & during floods etc.
- In this way it maintains pree determined level of water in reservoir and avoids damage of dam due to pressure of water.

b) State any four advantages and any 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.

c) The peak load on a power plant is 40 MW. The loads having maximum demands of 30 MW, 5 MW and 8 MW are connected to the power station. The annual load factor is 50% fmd. (i) Average load on power station. (ii) Demand factor (iii) Diversity factor (iv) Load factor

Ans:

Energy Supplied per year:-

$$\text{Number of units generated} = \text{Maximum demand} \times \text{Load factor} \times 8760$$

$$\text{Number of units generated} = 40 \times 10^3 \times 0.5 \times 8760$$

$$\text{Number of units generated} = 175200 \times 10^3 \text{ KWH}$$

$$\therefore \text{Energy Supplied per year} = 175.2 \times 10^6 \text{ KWH}$$ ----------**(1/2 Mark)**

i) Average load on power Station :-

$$= \frac{\text{Number of units generated in 1 year}}{\text{Number of hours in 1 year}}$$ ----------**(1/2 Mark)**

$$= \frac{175200 \times 10^3}{8760}$$

$$\text{Average load} = 20000 \text{ KW or } 20 \text{ MW}$$ ----------**(1/2 Mark)**

ii) Demand Factor :-

$$= \frac{\text{Maximum Demand}}{\text{connected load}}$$ ----------**(1/2 Mark)**

$$\text{Demand Factor} = \frac{40}{30+5+8}$$

Demand Factor = 0.9302 ----------(1/2 Mark)

iii) Diversity Factor :-

$$\textit{Diversity Factor} = \frac{\text{Sum of the individual consumer's maximum demand}}{\text{Maximum demand on power station}}$$ -(1/2 Mark)

$$\text{Diversity Factor} = \frac{30+5+8}{40}$$

Diversity Factor = 1.075 ----------(1/2 Mark)

iv)) Load factor $= \frac{\text{No.of units generated in one year}}{\text{M.D.} \times 8760}$

$$= \frac{175200 \times 10^3}{40 \times 10^3 \times 8760}$$

Load factor = 0.5 or 50 % ----------(1/2 Mark)

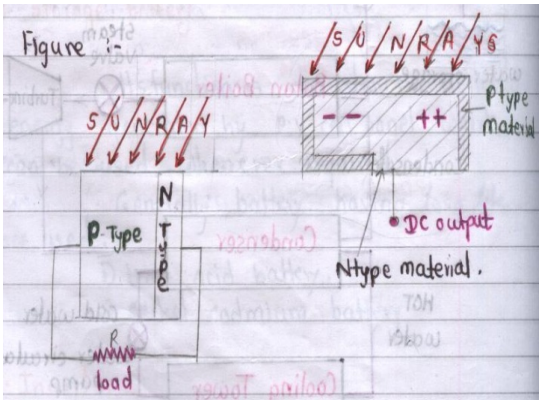
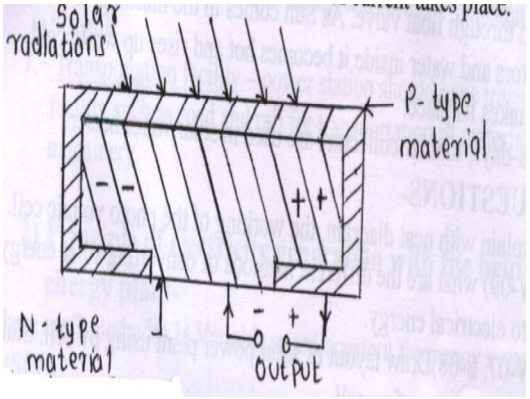
d) Discuss the special features of a turbo-alternator used in a thermal power station.

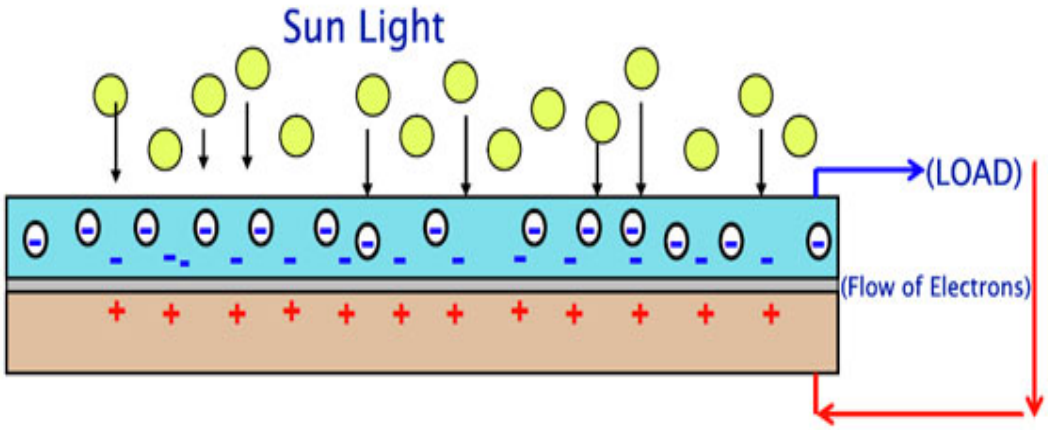
Ans: **Special Futures (Highlights):** **(Any four points are expected: 4 Marks)**

- 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 and 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 are 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 & over & under frequency protection, 4. Over temperature protection are main protections provided to alternator ➢ Power factor is 0.8 lagging, ➢ Better in dynamic balancing
e)	**Describe the fuel system and exhaust system of a diesel power station.**
Ans:	**(Each Explanation of Fuel System & Exhaust System ; 2 Mark, Total: 4 Mark)** **1. Engine Fuel system:** 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 **2. Engine Exhaust system:** ➢ This system is provided to discharge the engine exhaust (smoke) to the atmosphere outside the building at high level. It consists of ;

	➢ Silencer: - It is provided to reduce noise. ➢ Muffler: - It is provided to exhaust pipe to reduce pressure in exhaust line and eliminate most of the noise. **OR** **1. 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. **2. Air intake and exhaust system:** This system consists of pipes arrangement for admitting fresh atmospheric air into the diesel engine, and also to pump out the exhaust gases to the atmosphere. Filters are needed at the air inlet to remove dust particles etc. from the incoming air. At the outlet of the system silencer is provided to reduce the noise when the exhaust gases are coming out from the engine. In order to reduce the specific fuel consumption and to increase the engine capacity, the intake system must have to maintain minimum pressure loss.
f)	**'Running and maintenance costs of thermal power station are more than hydro power stations. Justify the statement.**
Ans:	**Reason for Statement:** **(4 Marks)** In thermal Power plant in addition to turbine & alternator following auxiliaries' are required which are not required in hydro electric power station. Hence 'Running and maintenance costs of thermal power station are more than hydro power stations . **(Any four points are expected)** 1. Coal conveyor 2. Pulverizer 3. Stoker 4. Boiler 5. Furnace 6. Economizer 7. Air preheater 8. Super heater 9. Re-heater 10. H.P and L.P. feed water heater 11. Draught System a) Forced Draught fan (FDF)

	b) Induced Draught fan (IDF) 12. Condenser 13.Cooling tower 15. Chimney or stack 16. Precipitator (dust collector) (*Electro-static precipitator*) 17. Ejector 18. Deaerator 19. Water treatment plant
Q.5	**Attempt any four of the following : 16 Marks**
a)	**Explain the role of control rod in a nuclear reactor. State any two materials for control rod.**
Ans:	**(Role of Control Rod:2 Mark & Any Two Materials Name expected: 1Mark each, Total: 4 Marks)** **Role of Control Rod :** Fuction of contrl rod is to be regulate fission process by absorbing the neutron. The control rod is inserted into the reactor core from top of the reactor vessel. **OR** The function of control rod is to control the chain reaction in reactor core by adjusting its height. **Following are the Materials used for control rod:** Material used for control rod i) Boron ii) Cadmium iii) Hafnium
b)	**Explain working of solar cell in solar power generation.**
Ans:	**Figure of Solar Cell:** **(Figure: 2 Mark & Working: 2 Marks, Total:4 Marks)**  **or** 



OR equivalent Figure

Working:-

- Sunlight consists of packets of energy called photons.
- When sunlight strikes the N-type layer, some of the waves of light energy penetrate up to the P-type layer.
- Than electrons are released from N-type material and holes are created in P-type material in this way electrical circuit is completed and flow of current takes place.
- This current is proportional to the number of photons hitting the cell and therefore the light intensity.

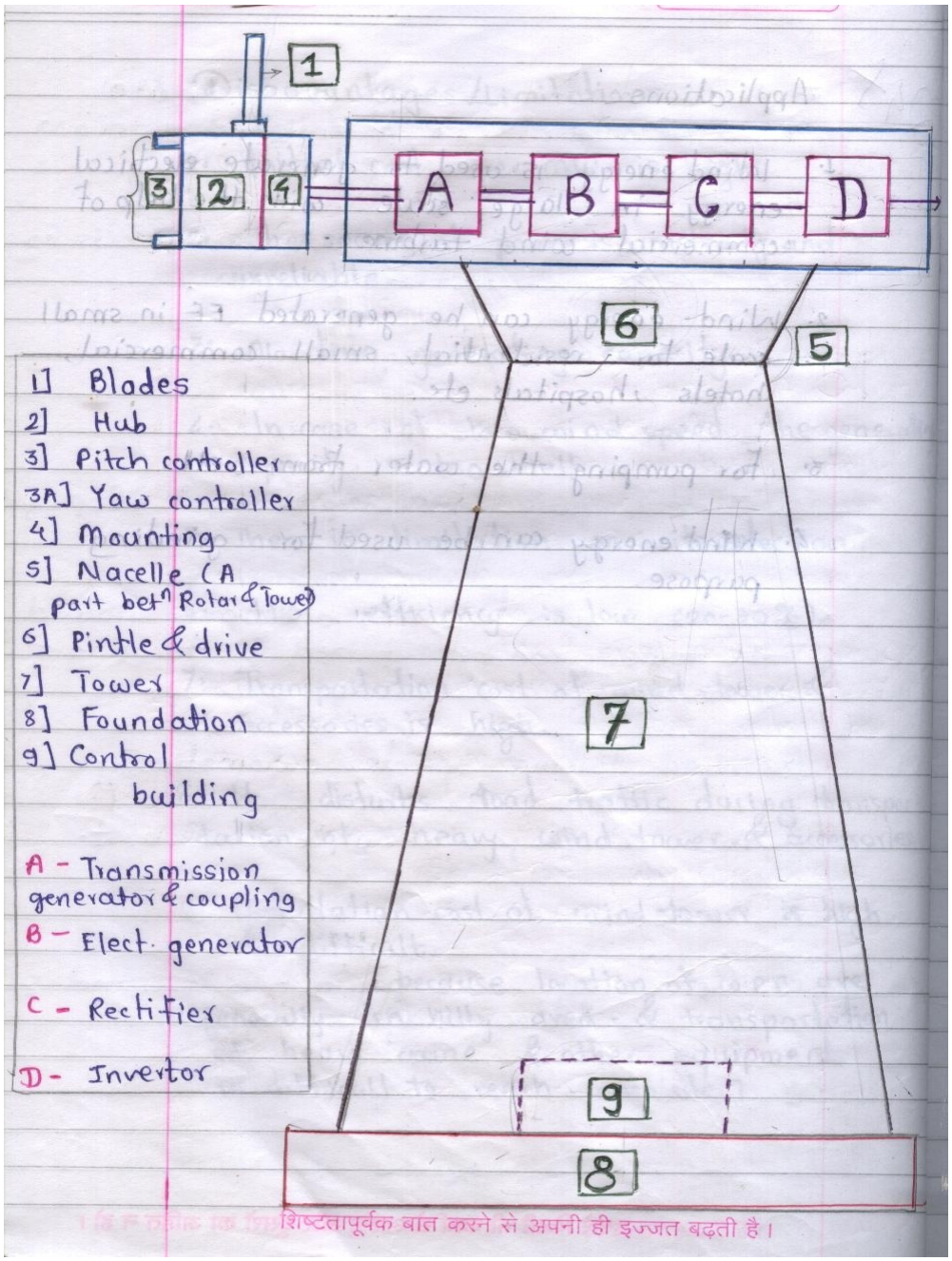
OR

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

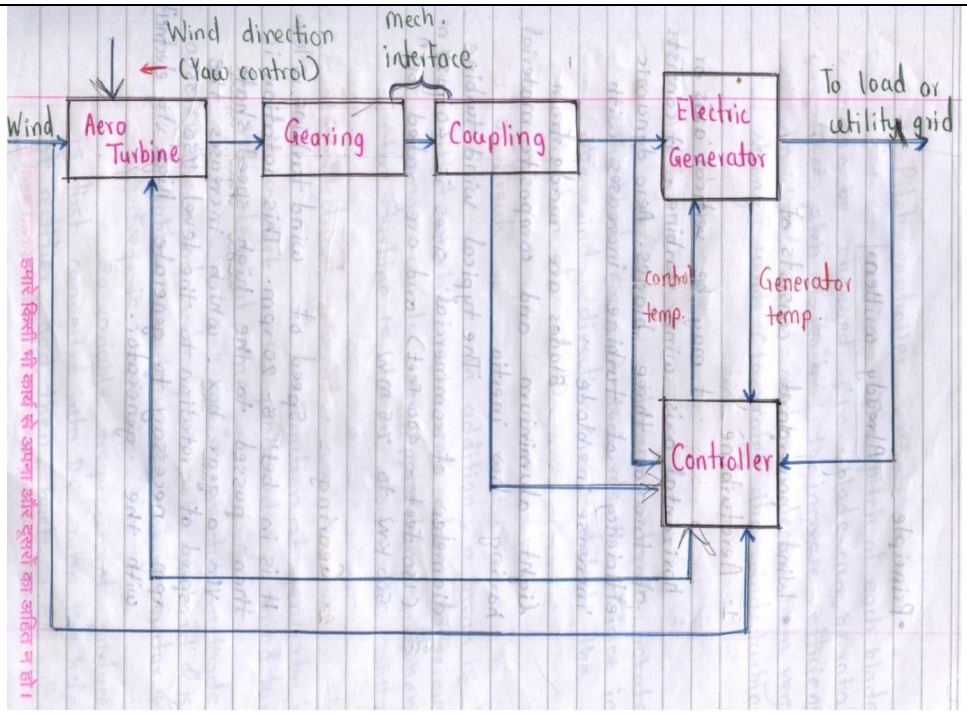
Solar cell works in following steps:

- Photons in sunlight hit the solar panel and absorbed by semiconducting material (such as silicon)
- Electrons (negatively charged) are knocked loose from their atom causing an electric potential difference.
- Thus converts solar energy into electrical energy without any waste products.

c)	Draw wind power plant diagram and show main components of wind power plant.
Ans:	(Diagram; 2 Mark, Showing of main components: 2 Mark, Total 4 Marks)



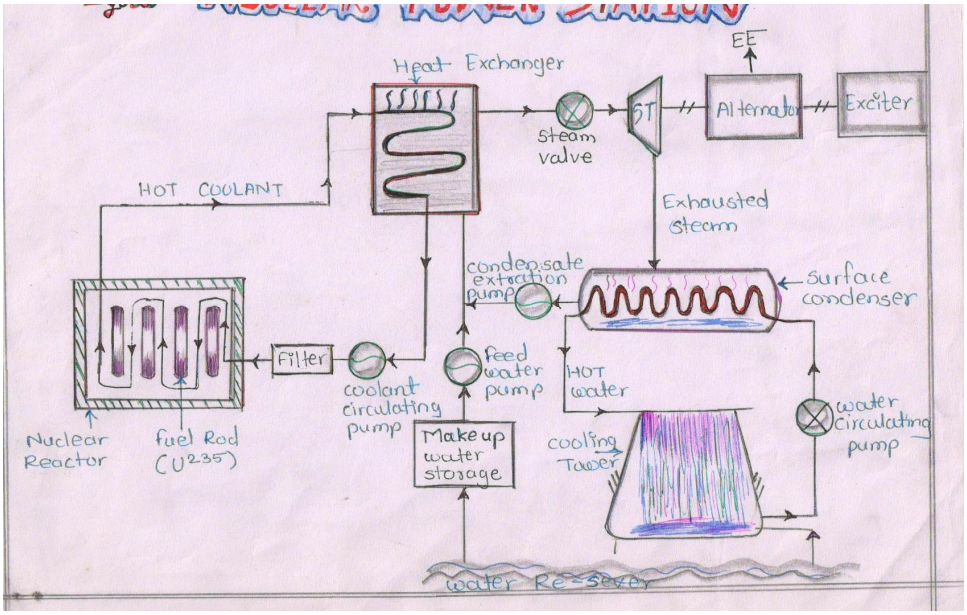
OR Equivalent figure



d) Explain the working of nuclear power plant with the help of neat sketch.

Ans: **Neat Sketch of Nuclear power Station:**

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



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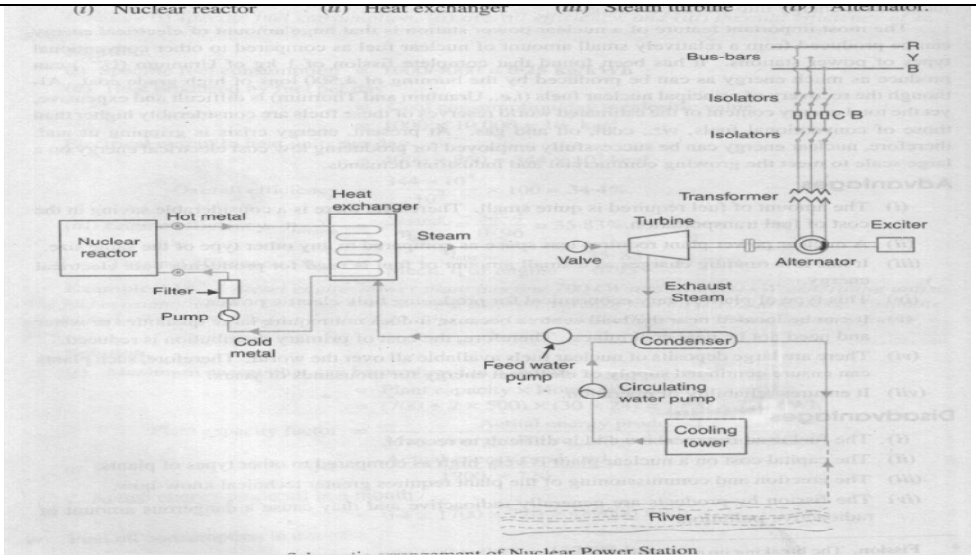


OR Equivalent Figure

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 the purpose of shielding and reflector in a nuclear reactor.

Ans: **(Explanation of Shielding: 2 Marks & reflector: 2 Marks, Total: 4 Marks)**

1. **Shielding:-** The function of sheilding is to protect environment, humens and animals from the harmful radioactive radiation (pollution).before they are emitted to atmosphere.
2. **Reflector:-** The function of reflector is to reflect escaping neutron from chain reaction.

OR

1. Shielding:

Shielding is provided to absorb alpha (α) beta (β) particles and rays (γ) which are produuced during nuclear chain reaction (fission process)

	The function of sheilding is to protect environment, humens and animals from the harmful radioactive radiation (pollution).before they are emitted to atmosphere. **2. Reflector:** Reflector surrounds the reactor core and moderator. The function of reflector is to reflect escaping neutron from chain reaction back into the core i) Due to reflecotr it helps to continue the chain reaction. ii) It saves the nuclear fuel. iii) Efficiency of reactor incrases.
f)	**Surge tank is compulsory in the case of high head hydropower plant. Give the reason.**
Ans:	**Reason:** **(4 Marks)** In the case of high head hydropower plant the distance between main reservoir and turbine valve house is more hence it is compulsory to have a surge tank to avoid damage of penstock due water hammer effect also to avoid cavity effect in penstock Surge tank is compulsory. **OR** **Surge Tank:-** **(4 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.
Q.6	**Attempt any Four of the following :** **16 Marks**
a)	**State any four advantages and any four limitations of wind energy.**
Ans:	**Advantages of wind energy system:** **(Any Four point Expected:1/2 each, Total: 2 Mark)** 1) Fuel is freely available. 2) Wind energy is inexhaustible. 3) There is no air pollution.

4) No fuel transportation cost.

5) No space is required to store fuel.

6) No need on treatment on fuel.

7) No waste disposal cost and problem.

8) Less manpower is required per MW.

9) Layout is simple.

10) Time required for completion of power plant project is less.

11) Space required is less and space around the tower can be utilized for farming or storage.

12) It works automatically i.e. wind turbine operates automatically.(Not required to start WPP)

13) Technology is simple and robust.

14) Generating cost per unit is less and is goes on decreases day by day.

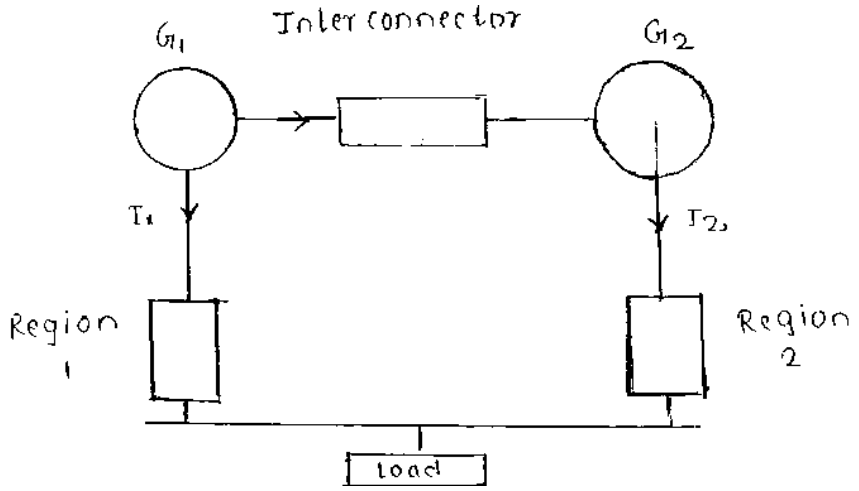
15) Maintenance cost is less.

16) Type of source is renewable.

Following are the Limitations of wind energy :

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

1. Initial cost per MW is high.
2. The source of power (wind) is unsteady and unreliable.
3. No firm generating capacity.
4. In case of low wind, power cannot be generated.
5. Its efficiency is low (20% -30%).
6. There is limitation on site selection.
7. Transportation cost of wind tower and accessories is high.
8. It disturbs load traffic during transportation of heavy wind tower and accessories.
9. Installation cost of wind tower is high and difficult (because of WPP are generally in hilly area and transportation of heavy cran and other equipments is difficult to reach up to the site.)

	10. Wind turbine produces noise. 11. Wind power systems have a relatively high overall weight.
b)	**Explain how load sharing is achieved between power stations in inter connected systems.**
Ans:	**(Figure:1 Mark & Explanation: 3 Marks, Total: 4 Marks)** $G_1$and G_2 should be so scheduled as to keep the generation cost per unit minimum. **or equivalent figure.**  **Load sharing:** ➢ Consider two generating Station G_1 and G_2 interconnected to each other through an inter connector (transmission line). ➢ Generator G_1 supplies current I_1 and G_2 supplies current I_2 to the load. ➢ If both the generators share the load equally and below its rated capacity, then there would be no flow of power through transmission line. ➢ But, if any one generator is overloaded, then transfer of power will take place through transmission line, this is called load sharing. ➢ This is done by connecting a regulating equipments at the start of each transmission line and in inter connector. **OR** ➢ Consider two generating station G1 and G2 operating in parallel and interconnected to each other through transmission line called as interconnected and these lines both locations of generating stations are at different location. As shown in figure 1 & 2. ➢ Each generator supplying power to local load and if required power can be transfer from G1 to G2 or G2 to G1. ➢ If required means in case of peak hours or failure of one of the generating station or in case of maintenance. ➢ When power transfer exceeds the capacity of single interconnector then in that case,

	power is transfer through two interconnector in parallel running along the same or different routes ➢ In this way load sharing between different generating station is achieve.
c)	**Explain importance of solar power in the energy defficient India.**
Ans:	Since avalabilty of fossile fuels like coal are limited in future so there is more importance of solar power in the energy defficient because of following advantages of solar power **(4 Marks) (Any Four Points are expected)** 1. Renewable energy sources and freely available. 2. No air pollution. 3. Availability of fuel is unlimited & inexhaustible. 4. No fuel storage is required. 5. No fuel transportation cost. 6. No treatment on fuel is required. 7. No waste disposal problem. 8. Generating cost per unit is less and reduces day by day 9. No need to start power plant. 10. It saves the fossil fuel (coal, diesel, oil etc) which are limited available. 12. Renewable technology are ideally suited to distributed applications (Decentralized system)
d)	**Explain why nuclear power plants are preferred as base load plants.**
	As nuclear Power plant full fills Following requirements which are suitable for supplying base load hence nuclear power plants are preferred as base load plants. **(Any Four Points are expected: 1 Mark Each: 4 Marks)** **1) Generating Capacity:** Its generating capacity should be large. **2) Firm:** It should have high firm generating capacity. **3) Reliable:** It should be reliable **4) Supply load continuously:** It must be able to supply load continuously

5) Generation cost:

Generating cost per unit (operating cost) should be less

6) Maintenance & running cost:

Maintenance, running cost should be less.

7) Facility readily available:

Spare parts, repair facility should be readily available

8) Location:

It should be located near load entre as far as possible.

e) The maximum demand of a power plant is 100 MW. The capacity factor is 0.6 and utilisation factor is 0.81. Find. (i) Load factor (ii)Plant capacity (iii) Reserve capacity (iv) Annual energy production

Ans: **Solution-**

Given data- M.D.=100 MW, U.F.= 0.81, C.F.=0.6

Find- the reserve capacity of the plant

Capacity factor = load factor x utilization factor

i) $\therefore$ **Load Factor** $= \dfrac{\textbf{Capacity factor}}{\textbf{utilization factor}}$ …… **(1/2 marks)**

$\therefore$ **Load factor** $= \dfrac{\textbf{0.6}}{\textbf{0.81}}$

$\therefore$ **Load factor** = 0.74 …… **(1/2 marks)**

ii) Plant capacity $= \dfrac{\textbf{maximum demand}}{\textbf{utilization factor}}$ …… **(1/2 Marks)**

$\therefore$ **Plant capacity** $= \dfrac{\textbf{100}}{\textbf{0.81}}$

$\therefore$ **Plant capacity** = 123.45 MW …… **(1/2 Marks)**

iii) Reserved capacity = Plant capacity - Maximum demand …… **(1/2 Marks)**

= 123.45 – 100

= **23.45 MW**…… **(1/2 Marks)**

iv) Annual Energy production:

= M.D x L.F. x 8760…….……...…… **(1/2 Marks)**

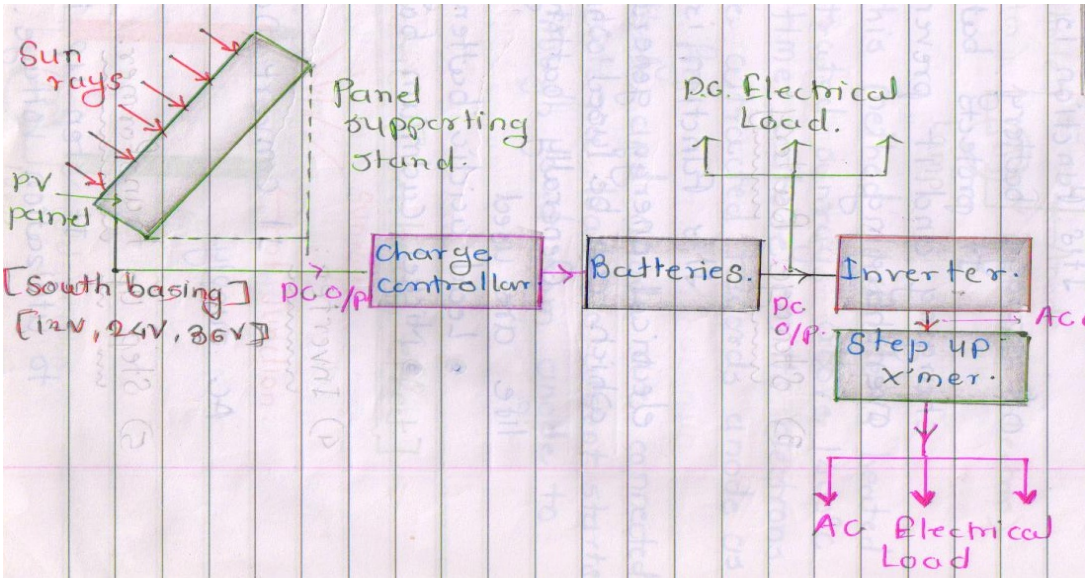
= 100 x10^3 x 0.74 x 8760

= 648240 x10^3 KWh.…… **(1/2 Marks)**

f) Draw the functional block diagram of photo volatic power generating system and explain each block in brief.

Ans: **Functional block diagram of photo volatic power generating system:**

(Block Diagram: 2 Marks & Explanation:2 Marks, Total: 4 Marks)



OR Equivalent Figure

Explanation:

Solar power plant consists of following components:

1. Photovoltaic cell panel:

Its function is to convert sunrays directly into DC electricity.

2. Battery charge Controller:

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

3. Storage Battery:

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

	whenever required. Generally battery having long life are used .There are two types of battery: 1. Lead acidic battery 2. Nickel cadmium battery **4. Inverter:** It convert DC supply into AC supply.. **5. Step-up transformer:** It step-up input voltage to utilization voltage e.g. 230V

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