



Important Instructions 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 should assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner should give credit for any equivalent figure/figures drawn.
- 5) Credits to 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 (as long as the assumptions are not incorrect).
- 6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC-27001-2005 Certified)

Summer – 2017 Examinations
Model Answer

Subject Code: 17324 (EPG)

1 Attempt **any ten** of the following:

20

1 a) List any two types of fuels used in electrical power generation plants.

Ans:

Types of fuels used in electrical power generation plants:

- 1) Solid fuels: Coal, Biomass: Wood, Nuclear fuel: Uranium, Plutonium
- 2) Liquid fuels: Diesel, Petrol
- 3) Gaseous Fuels: Natural gas, Producer gas

OR

- 1) Coal
- 2) Wood
- 3) Uranium
- 4) Plutonium
- 5) Diesel
- 6) Petrol
- 7) Natural gas
- 8) Producer gas

1 mark for
each of any
two fuels
= 2 marks

1 b) List any two thermal power plant with capacity and location in Maharashtra.

Ans:

Sr. No.	Name / Location	Plant Capacity
01.	Koradi	1100 MW
02.	Nashik	910 MW
03	Chandrapur	2340 MW
04	Parali	1130 MW
05	Bhusaval	920 MW
06	Paras	500 MW
07	Khaperkheda	1340 MW
08	TATA(Trombay)	1400 MW
09	Dhahanu (Thane)	500 MW
10	Wardha	135 MW
11	Amaravati	2700 MW
12	Jindal (Ratnagiri)	1200 MW

½ mark for
name/locati
on & ½
mark for
capacity
= 1 mark
each, any
two
=2 marks

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

Ans:

Different types of Condenser used in thermal power station:

- i) Jet Condenser(Mixing type)
- ii) Surface Condenser (Non mixing type)

1mark each
= 2 marks

1 d) List any two hydro power stations with capacity in Maharashtra.

Ans:

Sr. No.	Name / Location	Capacity
01.	Koyana	1960 MW
02.	Mulshi Dam	150 MW
03.	Jayakwadi	12 MW
04.	Chandoli (Warana)	16 MW
05.	Ujani	12 MW
06	Bhira Tail Race	80 MW
07	Veer	9 MW

½ mark for
name/locati
on & ½
mark for
capacity
= 1 mark
for each of
any two
= 2 marks



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08	Bhatghar	16 MW
09	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

1e) Write any two disadvantages of hydro power plant.

Ans:

Disadvantages of hydro power plant:

- Due to high cost of civil engineering works, the capital cost per kW of hydro plants is considerably higher than that of steam plants. 1 mark
- Hydro power generation is dependent on availability of water. In dry year, the power generation is very small. each, any
- The firm capacity of hydro plants is low and needs to be backed up by steam plants. two
- Since hydro plants entail huge civil engineering works, they take a considerably long time for completion. = 2 marks
- Hydro plant reservoir submerges huge areas, uproots large population and creates social and other problems.

1f) State any two nuclear power plant with capacity in India.

Ans:

Sr. No	Name	Location	State	Capacity (MW)
1	Tarapur Atomic power station (APS)	Tarapur	Maharashtra	1400
2	Madras APS	Kalpakkam	Tamilnadu	440
3	Kaiga APS	Kaiga	Karnataka	660
4	Kakrapur APS	Surat	Gujrat	1840

½ mark for name/location & ½ mark for capacity = 1 mark for each of



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Model Answer

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6	Kundankulam APS	Kundankulam	Tamilnadu	4000
7	Narora APS	Narora	U.P.	440
8	Rajasthan APS	Pawatbhata	Rajasthan	1180

any two
= 2 marks

1 g) Write any two factors for selection site for nuclear power plant.

Ans:

- Seismicity:** If the area of a nuclear site is seismically active, it may not be used for nuclear power plant.
- Water Availability:** The nuclear power plants would need a lot of water for power production. So this criterion must be taken into consideration.
- Flooding:** A nuclear power plant has to be protected from the static and dynamic effects of flooding. Therefore, the site should not be in areas where the flood is susceptible to occur.
- Away from populated area:** Although there is always tight safety but still there are chances of radioactive radiation, which affects the health of people. Therefore, it must be away from the populated areas.
- Nearest to the load centers:** Since the transportation and storage requirements are less compared to the coal fired plants. It is preferred to construct the nuclear power plant near to the load centers so that transmission of energy at minimum cost can be achieved.
- Disposal of waste:** The waste produced by fission in nuclear power station is generally radioactive which must be disposed off properly to avoid health hazards. The waste should either be buried in a deep trench or disposed off in a sea quite away from the sea shore. Therefore, the site selected for such plant should have adequate arrangement for the disposal of radioactive waste.

1 mark for
each of any
two
= 2 marks

1 h) State the different types of engines in diesel power plant.

Ans:

Types of engines in diesel power plant:

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

1 mark
each
= 2marks

1 i) Write the meaning of captive power generation.

Ans:

Captive power generation:

The 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 its own use & sell excess power to state electricity board is known as Captive power generation.

2 marks for
correct
answer

1 j) Define: i) Connected load ii) Firm power.

Ans:

- Connected load:** The connected load of a consumer is the sum of continuous rating of all equipment of the consumer connected to supply system which is in use or not in use.
- Firm power:** It is the power which is always available from the plant even during adverse condition.

1 mark
each
= 2 marks

1 k) Write formulae for solar constant.



Ans:

Solar Constant is given by,

$$I_{SC} = \frac{I_{ext}}{\left[1.0 + 0.033 \cos\left(\frac{360n}{365}\right)\right]} W/m^2$$

OR

$$I_{SC} = I_{ext} \left[\frac{R}{R_{av}}\right]^2 W/m^2$$

1 Mark for
each = 2
Marks

where, I_{ext} is the extraterrestrial radiation.

R_{av} is the mean distance between the sun and the earth.

R is the actual sun-earth distance

n is the no. of days from first January.

- 11) State any two limitations of wind energy.

Ans:

Limitations of wind energy:

- 1) Wind turbine produces noise.
- 2) Its efficiency is less (20% to 30%)
- 3) There is limitation on site selection.
- 4) Transportation cost of wind tower and accessories is high.
- 5) Its reliability to generate power is less.
- 6) No firm power.
- 7) Power generation is not in phase with the demand.
- 8) Generation is costly.

1mark for
each of any
two
limitations
= 2 marks

- 2 Attempt **any four** of the following:

16

- 2a) Write any four advantages and four disadvantages of thermal power plant.

Ans:

Advantages of thermal power plants :

- i) Less initial cost as compared to other power plants.
- ii) It requires less space as compared to hydroelectric plants.
- iii) The main fuel used in these plants is coal which is quite cheap.
- iv) It can be installed at any place irrespective of the existence of fuel while the hydroelectric plants can be developed only at the source of water supply.
- v) Such power plants are able to respond to rapidly changing loads without difficulty.
- vi) Transmission costs in such plants are reduced because these plants can be located near the load centers while hydroelectric plant have essentially to be installed at source of water power thus increasing transmission costs.
- vii) The cost of generation is lesser than that of the diesel power station.
- viii) A portion of steam raised can be used as process steam in various industries such as sugar mills, paper mills, refineries, textile mills, plastic manufacture and chemical works etc.

½mark for
each of any
four
advantages
= 2 marks

Disadvantages of thermal power plants:

- i) High maintenance and operating costs.
- ii) It pollutes the atmosphere due to the production of large amount of smoke and fumes.

½ mark for
each of any
four

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- | | |
|--|----------------------------|
| iii) Disposal of ash is quite difficult. | disadvantages
= 2 marks |
| iv) Requires huge quantity of water. | |
| v) Handling of coal is difficult. | |
| vi) Costlier in running cost as compared to hydroelectric plant. | |

2b) State any four factors for selection of hydro power plant site.

Ans:

Factors governing selection of site for hydroelectric power plant:

- 1) **Availability of water:** Primary requirement of hydropower station is availability of huge amount water. 1 mark for each of any
- 2) **Storage of water:** Sufficient space should be available to collect the water during high flow period (rainy season) and use it throughout the four factors = 4 marks
- 3) **Head of Water:** Stored water must have high head as it reduces quantity of water required to run the turbine.
- 4) **Soil condition:** It must have sufficient strength to withstand the heavy dam structure.
- 5) **Geographical situation:** The location can offer advantage to store huge amount of water and also for dam construction.
- 6) **Transportation facility:** The site should be accessible by rail and/or road so that necessary equipment & machinery can be easily transported.
- 7) **Near to the load centre:** To reduce the cost of transmission lines, the site should be near to the load centre.
- 8) **Cost of land:** The land must be cheaply available.
- 9) **Free from earthquake zone:** For safety of huge dam structure and water storage.
- 10) **Silt and debris (unwanted solid particles):** The catchment area should be such that there are less accumulation of silt and debris.
- 11) **Water pollution:** Water should be free from chemical impurities.

2c) State any four advantages and four disadvantages of diesel electric power plant.

Ans:

Advantages of Diesel electric power plant:-

- 1) The design and layout of Diesel electric power plant 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 Diesel power plant is higher than Thermal power plant.
- 13) Power plant is simple in operation.



- 14) It requires less operating & supervising staff.
- 15) Such power plant gives quick response 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:-

- 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 cannot supply overload continuously.
 - 7) Due to production of smoke, there will be air pollution
 - 8) It produces noise pollution from the exhaust.
 - 9) The useful life is very short.
 - 10) Availability of fuel in future may be limited.
- ½ mark for each of any four disadvantages = 2 marks

2d) State any four advantages of interconnected system.

Ans:

Advantages of interconnected Systems:

- i) **Reduced Overall installed Capacity:** Inter connected power systems reduce the overall requirement of installed capacity for a given load area. With interconnection between power systems, peak demand in an area is met 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) **Ensure Economical operation:** The interconnected system makes
- 1 mark for each of any four advantages = 4 marks



the operation of concerned power station quite economical. It is because sharing of loads among the stations is arranged in such a way that the plants having higher cost of generation 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 much 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.

- 2e) Compare conventional energy sources with renewable energy sources on any four points.

Ans:

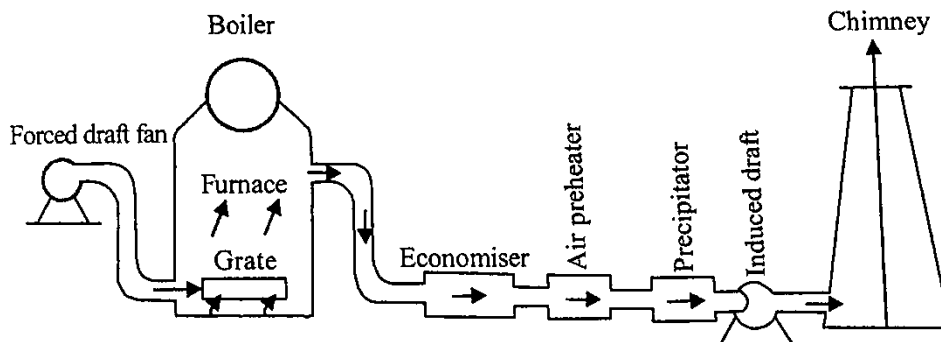
Comparison between conventional energy sources and renewable energy sources:

Sr. No.	Points	Conventional Energy Sources	Renewable Energy Sources
(i)	Availability	Limited	Unlimited
(ii)	Cost of Fuel	High depending on fuel.	Negligible
(iii)	Amount of Power generated	On large scale due to huge plants possible	Limited due to need of advancement in cheaper techniques of harnessing them
(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 except HPP	No air pollution
(viii)	Size of /site selection	Different criteria for different P.P	Site should be selected at source
(ix)	For example	HPP, TPP, NPP	SPP and WPP

1mark for
each of any
four points

- 2f) Draw the labeled diagram of flue gas flow related to thermal power plant.

Ans:



Flue gas flow diagram of a thermal power plant

4 marks for
labeled
diagram

2 to 3
marks for
partially
labeled
diagram

1 mark for
unlabeled
diagram

3 Attempt **any four** of the following:

16

3a) State any four factors governing for selection of site for thermal power plant.

Ans:

Factors governing the selection of site for Thermal Power Plant:

1. **Distance from coal mines:-**The power plant should be located near the coal mines, to reduce cost of fuel transportation.
2. **Availability of Water:-**Water is as good as secondary fuel so ample amount of water should be available nearby. So, plant should be located near large water reservoir, lake, river or ocean.
3. **Easy access:-**There should be easy access towards site of power plant for transportation of machinery, equipment, man power, fuel etc.
4. **Availability of land:-**Sufficient large space should be available to build the power plant, for storage of coal, for storage of ash, for staff quarters and also for future expansion of the power plant. Also, the plant should be constructed on plane land.
5. **Cost of land:-**Cost of land should be less to reduce capital cost of power plant.
6. **Condition of land soil:-**The land should have high bearing capacity. It should not be too loose or too hard, for economical and better foundation of machinery, equipment and buildings.
7. **Distance from populated area:-**As TPP produces air pollution; PP should be located away from populated area.
8. **Near Load Centre:-**Plant should be located near load center to reduce transmission cost & losses.
9. **Away from airport:-**As height of chimney is very high, it should be located away from airport.
10. **Availability of labour:-**Skilled and unskilled labour should be available nearby.
11. **Earthquake:-**Area should be free from earthquake and other natural hazards.

1 mark for
each of any
four factors
= 4 marks



3b) Write any four advantages of hydropower plant.

Ans:

Advantages of hydropower plant:

1. There is no air pollution and other environmental problems.
2. The material means of power generation (water) is available freely.
3. No fuel transportation cost so; hence there is no need of fuel handling equipment.
4. No treatment on fuel is required. 1 mark for
5. No fuel waste is produced (like ash) so, no waste disposal problem. each of any
6. Fuel can be used again and again. (Renewable energy sources) four
7. Generating cost is less and reduces day by day. advantages
8. It saves fossil fuels (coal diesel oil etc.) which are limitedly available = 4 marks
9. Less man power is required per MW so, running cost is less.
10. Layout is simple. Auxiliaries are considerably less than those in the case of a thermal power station.
11. Power generation can be controlled quickly & rapidly without any difficulty. (By simply controlling flow of water)
12. There are no standby losses.
13. Efficiency of plant is highest (above 97%) and does not change with age.
14. Operating & maintenance cost are very low.
15. The life of plant is longest.
16. In addition to generation of electric energy H.P.P. is also useful for supply of drinking water, supply of water for irrigation purpose and it control the flood also.
17. Since, hydroelectric stations are situated far away from populated areas so the cost of the land is low.
18. The cost per kWh of a hydroelectric station is not considerably affected by the load factor, as in the case of a Thermal / Nuclear / Diesel Power P.
19. It is very neat & clean plant.

3c) Define :

- | | |
|----------------------|--------------------|
| i) Diffuse radiation | ii) Beam radiation |
| ii) Insolation | iv) Solar constant |

Ans:

i) Diffuse radiation:

It is the solar radiation which is scattered by the particles in earth's atmosphere and this radiation does not have any unique direction. 1 mark for each definition

ii) Beam radiation:

Solar radiation along the line joining the receiving point and the sun is called beam radiation. This radiation has unique direction.

iii) Insolation:

It is defined as the total solar radiation energy received on a horizontal surface of unit area on the ground in unit time.

iv) Solar constant:

It is defined as the energy received from the sun per unit time on unit



surface area perpendicular to the direction of propagation of solar radiation at the top of earth's atmosphere when earth is at its mean distance from the sun.

OR

It is the average radiation received outside the earth's atmosphere.

- 3d) Explain the nuclear chain reaction in a nuclear power plant.

Ans:

Nuclear chain reaction in a nuclear power plant:

If a slow moving neutron hits unstable heavy nucleus of nuclear fuel U^{235} or Pu^{239} , the neutron is absorbed, the nucleus splits into two more nuclei, two or three neutrons are usually released with lot of heat energy and radiation of alpha, beta, gamma particles which are hazardous to human body. The heat energy is about 85% of energy released from this fission. Further these neutrons strike other nuclei causing them to split and release two or more neutrons and lot of heat energy.

2 marks

This chain or cycle will continue and enormous amount of heat energy will be liberated, hence this process is called as chain reaction. The chain reaction is controlled by the moderator and control rods in nuclear power plant. The moderator slows down the neutrons and control rods absorb the neutrons, thus chain reaction can be controlled and desired heat energy can be obtained in nuclear power plant.

2 marks

- 3e) A plant having load factor of 0.6 has peak load of 110MW. Calculate energy generated by this plant in one month of 30 days.

Ans:

Data Given: Load factor = 0.6

Period = 30 days

Peak load = 110 MW

Energy generated

$$= (\text{Average load in kW}) \times \text{No. of hours in a month}$$

1 mark

$$= (\text{Peak load in kW} \times \text{load factor}) \times \text{No. of hours in a month}$$

$$= (110 \times 1000 \times 0.6) \times 24 \times 30$$

2 marks

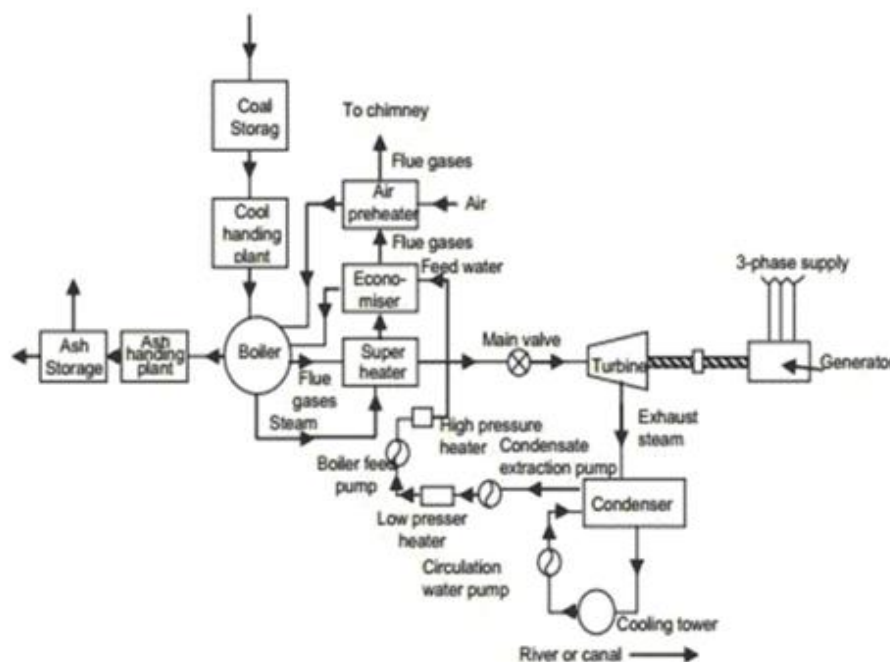
$$= 4,75,20,000 \text{ kWh or units}$$

1 mark

- 3f) Draw a labeled schematic block diagram of thermal power plant showing all the components of the plant.

Ans:

Schematic block diagram of Thermal Power Plant:



4 marks for
labeled
diagram

2 to 3
marks for
partially
labeled
diagram

1 mark for
unlabeled
diagram

OR

Any equivalent diagram

4 Attempt **any four** of the following:

16

4 a) State the function of superheater and economizer.

Ans:

Function of Superheater :

The steam produced in the boiler is not dry but contains some moisture. Such wet steam can damage/corrode and reduce the efficiency of the plant. Hence before supplying wet steam to turbine, it is passed through super-heater, where it is dried and superheated by the flue gases. Super-heater increases the overall efficiency of the plant.

2 marks

Function of Economizer:

It extracts the heat from flue gases and utilizes this heat to raise the temperature of feed water to the boiler, so that efficiency of overall system is increased.

2 marks

4 b) Explain working of pumped storage plant.

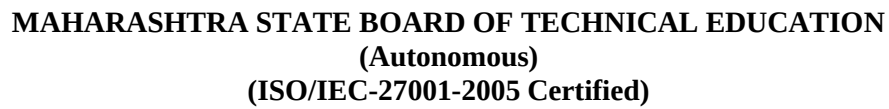
Ans:

Pumped storage Hydro power plant:

These power plants are used when quantity of water available for generation of electricity is limited or insufficient. The water from upper reservoir is passed through penstock to turbine, where its energy is converted in to electricity and then it is released in lower reservoir. The generation of electricity is usually carried out during peak load periods. During off-peak periods, the same water from lower reservoir is pumped back to upper reservoir. Thus the limited quantity of water can be reused again and again. For this kind of operation two types of arrangements are used:

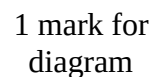
3 marks
for
explanation

- Separate arrangement for pumping back the water: In this case separate pumps are used to lift the water from lower reservoir to upper



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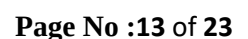
ii) **Reversible Turbine Pump Unit:** In this arrangement, the machine is operated as turbine during electricity generation and the same machine is operated as pump to lift the water from lower reservoir to upper reservoir through penstock. The figure shows this arrangement. The energy utilized for pumping during off-peak period is recovered by electricity generation during peak period and same water is reused.



- Ans:**

The diagram illustrates the control system of a wind turbine. It starts with 'Wind' and 'Wind speed' as inputs. The 'Wind' input goes to the 'Aero-turbine' block, which also receives 'Pitch control' and 'Wind direction (yaw control)'. The 'Aero-turbine' is connected to a 'Gearing' block, which is part of a 'Mechanical interface' along with a 'Coupling' block. The 'Gearing' block outputs 'Speed & torque' to the 'Coupling' block. The 'Coupling' block is connected to an 'Electrical generator' block. The 'Electrical generator' outputs 'Load' and 'Temperature' signals. The 'Temperature' signal goes to a 'Controller' block. The 'Controller' block receives 'Speed & torque' from the 'Coupling' block and 'Out-put power' from the 'Electrical generator'. The 'Controller' outputs 'Control signal' to both the 'Coupling' and 'Electrical generator' blocks. The 'Control signal' from the 'Coupling' block also goes to the 'Aero-turbine' block. The 'Controller' also outputs 'Pitch control' to the 'Aero-turbine' block.

OR





Components of wind power plant and their functions:

1) Rotor /Blade/Aero-turbine:

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

2) Hub:

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

2 marks for
functions

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 minute.

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 1800rpm 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) Brakes:

The brakes are fitted to stop the wind turbine. By applying the brakes when dangerously strong wind are approaching i.e. when wind speed exceeds 55-65 miles per hour, the wind turbine is stopped to avoid damage. In case of emergency also it is used to stop the rotation of turbine. To take down the turbine for maintenance, brakes are applied to stop it.

7) Yaw Controller:

It brings the blades towards the face into the wind direction i.e. it detects the direction of wind. It performs 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 is a wind direction sensor with digital display. Used in areas where AC power is not available. It monitors wind speed and stores max and average value.

11) Controller:

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

The controller sense wind direction & wind speed

The controller protect wind turbine from abnormal wind conditions,



excessive temperature rise of generator, electrical fault etc.

12) Nacelle:

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

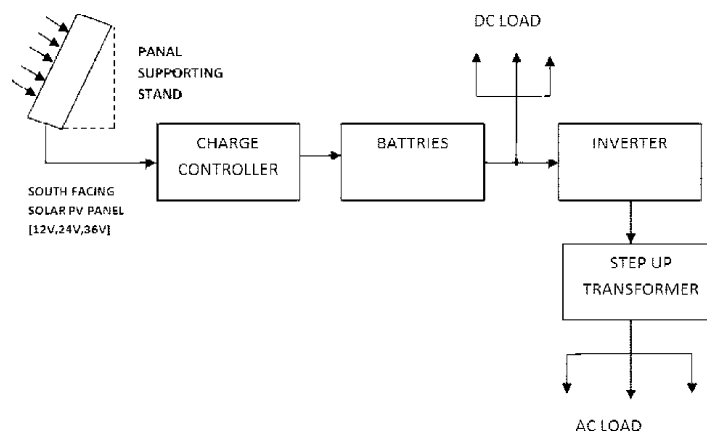
13) Tower:

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.

- 4 d) Explain with block diagram photovoltaic power generation.

Ans:

Photovoltaic power generation:



2marks for
diagram

Photovoltaic power generating system consists of following components:

1. Photovoltaic cell panel:

Its function is to convert energy content of 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. 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 batteries having long life are used. There are two types of battery:

1. Lead acidic battery
2. Nickel cadmium battery

4. Inverter:

It converts DC supply into AC supply.

5. Step-up transformer:

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

2 marks for
explanation

- 4 e) Explain starting system in diesel electric power plant.

Ans:

Starting system in Diesel Electric Power Plant:

It includes Storage battery, compressed air tanks, self-starter etc. The



purpose of engine starting system is to rotate the engine initially while starting, until firing starts and the unit runs with its own power. Small sets are started manually by handles but for larger units above 75kW, compressed air is used for starting. Air at high pressure is admitted to a few of cylinders making them to act as reciprocating air motors to turn over the engine shaft. The fuel is admitted to the remaining cylinders which makes the engine to start under its own power.

4 marks for
correct
explanation

In addition to above the diesel power plants are provided with different instruments such as Ammeters, Voltmeters, Wattmeters, Thermometers, Pressure gauges, Visible and audible alarm etc.

- 4f) The peak load on a power plant is 40MW. The loads having maximum demand of 30 MW, 5 MW and 8 MW are connected to the power station. The annual load factor is 50% find :

- i) Average load on the power station ii) Demand factor
ii) Diversity factor iv) Load factor

Ans:

Data given:

Maximum demand on power plant MD = 40 MW = 40×10^3 kW

Individual maximum demands: MD₁ = 30 MW

MD₂ = 5 MW

MD₃ = 8 MW

1 mark for
each bit

Annual load factor: LF = 50% = 0.5

Energy Supplied per year:-

Number of units generated = Maximum demand × Load factor × 8760
= $40 \times 1000 \times 0.5 \times 8760 = 175200000$ kWh.

i) Average load on the power station :

$$= \frac{\text{No. of units generated in one year}}{\text{No of hours in one year}} = \frac{175200000}{8760} = 20000 \text{ kW} = 20 \text{ MW}$$

ii) Demand Factor :

$$= \frac{\text{Maximum demand}}{\text{connected load}} = \frac{40}{30 + 5 + 8} = 0.9302$$

iii) Diversity Factor :

$$= \frac{\text{Sum of individual consumers maximum demand}}{\text{Maximum demand on power station}} = \frac{30 + 5 + 8}{40} = 1.075$$

iv) Load Factor:

$$= \frac{\text{No. of units generated in one year}}{\text{Maximum demand} \times 8760} = \frac{175200000}{40000 \times 8760} = 0.5 \text{ or } 50\%$$

- 5 Attempt **any four** of the following :

16

- 5a) State any four advantages of wind energy.

Ans:

Advantages of wind energy system:

1. Wind input (energy) is freely available



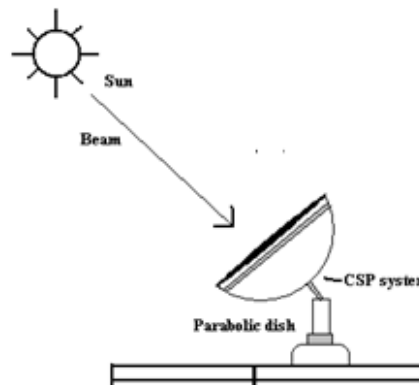
2. Wind energy is inexhaustible
3. There is no air pollution
4. No fuel transportation cost.
5. No space is required to store fuel.
6. No need on treatment on fuel.
7. No waste disposal cost and problem.
8. Less manpower is required per MW.
9. Layout is simple.
10. Time required for completion of power 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 decreasing day by day.
15. Maintenance cost is less.

1 mark for
each of any
four
advantages

5b) Explain with schematic diagram direct distribution of solar energy.

Ans:

Schematic diagram of direct distribution of solar energy:



2 marks for
diagram

OR

Equivalent Diagram

Solar energy reaching earth's surface consists of two components:

i) Direct solar energy, ii) Diffused solar energy.

Direct solar energy is the energy reaching earth's surface with the Sun's beam. The Sun's beam has high heat content. Solar radiation that has not been absorbed or scattered and reaches the ground directly from the Sun is called Direct radiation or beam radiation. It is very intense radiation and it can produce sun burns and shadows.

2 marks for
explanation

5c) Explain the working of BWR nuclear power plant.

Ans:

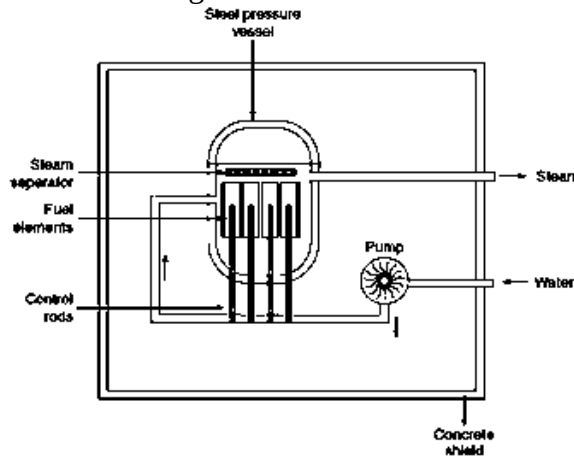
Working of BWR nuclear power plant:

- i) In BWR the steam is generated in the reactor itself. There is no need of heat exchanger.
- ii) Fuel used is Enriched Uranium.
- iii) Moderator used is light or heavy water.
- iv) Coolant used is light or heavy water.

2 marks for
explanation



- v) Temperature obtained is 280°C .
- vi) Efficiency is 33 %.
- vii) Steam pressure is 68 Kg/cm^2 .

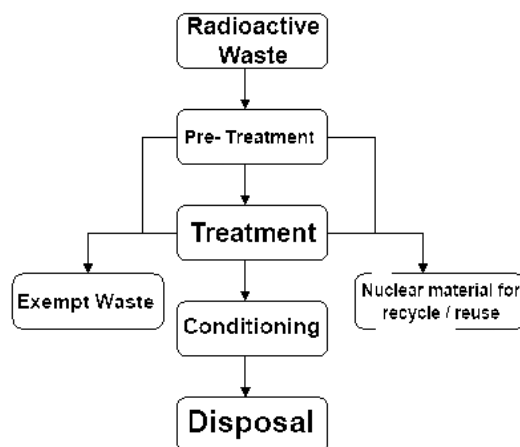


2 marks for
diagram

- 5d) Explain the procedure for disposal of nuclear power plant.

Ans:

Procedure for disposal of nuclear waste: (Sample block diagram)



2 marks for
diagram

OR

Equivalent diagram

Disposal of nuclear waste:

The waste products by nuclear fission may be solid, liquid or gas.

- i) Solid harmful disposals are packaged as required and shipped to a burial site for disposal.
- ii) Liquids are processed through filters, boiling and leaving the solid impurities. The process is carried out till the pure water is obtained from the disposal. The waste is then released to environment.
- iii) Gaseous wastes are filtered, compressed to take up less space and then allowed to decay for some period. After the require time has been passed, the gases are sampled and tested. If the required limits are met, these will be released to atmosphere.

2 marks for
explanation



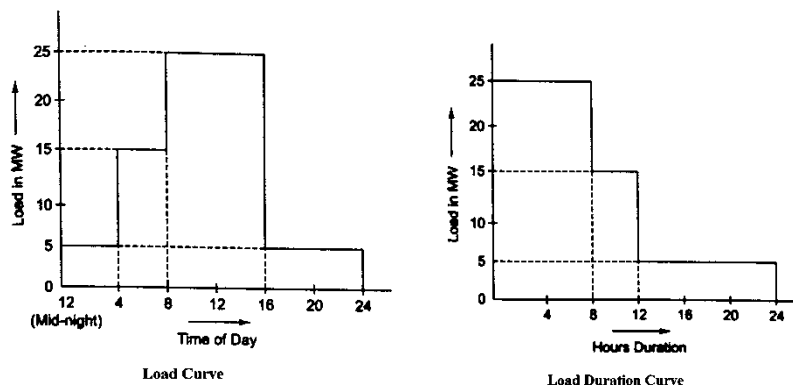
5e) Explain with diagram load duration curve.

Ans:-

Load duration curve:

This curve represents the load vs. time with the ordinates rearranged in magnitude sequence i.e. with the greatest load on the left, lesser loads toward the right and least load at the extreme right. This curve is obtained from load curve and gives the number of hours for which a particular load lasts during the day. The area under the load duration curve and the area under the load curve are equal. The area under this curve gives the total number of units generated for the period considered.

2 marks for
explanation



2 marks for
diagram

5f) State the classification of hydro power plant

- I) According to load II) Pumped storage power plant

Ans:-

Classification of hydro power plant according to load :

2 marks

1. Base-load plants
2. Peak –load plants

Classification of hydro power plant according to Pumped storage power plant :

2 marks

1. Run-off river plant without poundage
2. Run-off river plant with poundage
3. Reservoir plants

OR

Equivalent classification

6 Attempt any four of the following :

16

6a) State any four salient features of turbo- alternator.

Ans :-

Salient features of turbo alternator:

- 1) Turbo-alternators are high-speed alternators (3000 rpm).
- 2) Rotor diameter is kept less to limit the centrifugal force acting on field winding on rotor at high speeds.
- 3) Rotor axial length (along shaft) is more.
- 4) Cylindrical rotor construction (non-salient pole) is used.
- 5) Field poles are less in number either 2 or 4.

1 mark for
each of any
four
features

6b) State any two advantages and two disadvantages of nuclear power plant.



Ans:

Advantages and disadvantages of nuclear power plant :

Advantages :

- 1) Fuel requirement for generating a given amount of electrical energy is very small as compared to others.
- 2) It is efficient when operated at rated capacity.
- 3) They reduce the demand for coal, gas and oil.
- 4) Fuel requirement is only in kilograms. Hence, there is no problem for transportation, storage etc.
- 5) It requires less area as compared to any other plant of the same size.
- 6) The running costs are less.
- 7) For large capacity, nuclear power plants are more economical.
- 8) The cost per unit decreases when power generated is in large amount.
- 9) Output control is extremely flexible as these are not affected by adverse weather conditions.
- 10) There are large deposits of nuclear fuels available all over the world, therefore such plants can ensure continued supply of electrical energy for thousands of year.
- 11) It ensures reliability of operations.
- 12) Operation is clean, no ash fumes etc.

1mark for
each any
two = 2
marks

Disadvantages:

- 1) High initial capital cost as compared to other types of power plant.
- 2) These plants are not suitable for varying loads, as reactors cannot be easily control.
- 3) It is difficult to seal the plant from radioactive radiation.
- 4) The disposal of fission products is a big problem.
- 5) The maintenance cost is high.
- 6) The fuel required is not readily available.
- 7) The erection and commissioning work is complicated and requires expertise.
- 8) The danger of radiation is always there & high safety standards are to be practiced and maintained.
- 9) There is always a danger of accident or terrorism when transporting nuclear fuel or nuclear waste.
- 10) Enrichment technology is essential for fuel processing.

1mark for
each any
two = 2
marks

6c) Explain fuel system and air intake system in diesel electric power plant.

Ans:

Fuel system and air intake system in diesel electric power plant :

Fuel system:

It consists of storage tank, strainers, fuel transfer pump and all day fuel tank. The fuel oil is supplied at the plant site by rail or road. The oil is stored in the storage tank. From the storage tank, oil is pumped to smaller all day tank at daily or short intervals. From this tank, fuel oil is passed through strainers to remove suspended impurities. The clean oil is injected into the engine by fuel injection pump.

2 marks

Air intake system:

This system supplies necessary fresh atmospheric air to the engine for fuel

2 marks

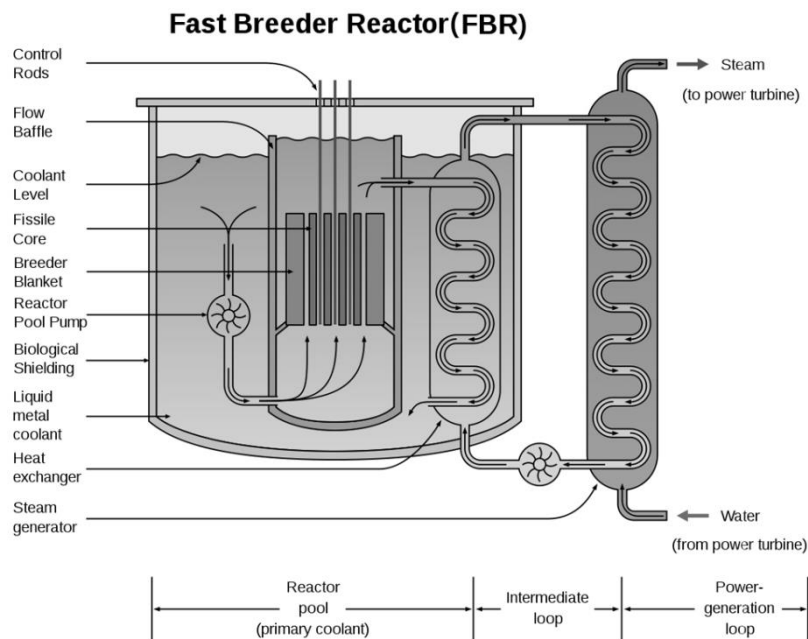


combustion. It consists of pipes for the supply of fresh air to the engine manifold. Filters are provided to remove dust particles from air which may act as abrasive in the engine cylinder.

6d) Explain working of fast breeder reactor.

Ans:

Fast Breeder Reactor (FBR):



2 marks for
diagram

A fast breeder reactor produces heat and at the same time converts fertile material into fissionable material. The central portion of this reactor is a stainless steel pot in which a core of fissionable material is kept. The Fuel used is natural or enriched Uranium. This core of fissionable material is surrounded by a blanket of breeder (fertile) material (U_{238} or Th_{232}). In this type of reactor, two heat exchangers are used. The reactor core is cooled by liquid sodium / potassium. In the second heat exchanger, the coolant is again liquid sodium/potassium which transfers heat to feed water. A neutron shield (graphite) separates the reactor core and primary heat exchanger.

2 marks
for
explanation

The fertile material absorbs neutrons produced by chain reaction and thus produces fissile material (Pu_{239} or U_{233}). 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.



6e) Define the following terms and state their significance :

- I) Hydrology II) Surface runoff
III) Evaporation IV) Precipitation

Ans:

(i) **Hydrology:**

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

Hydrology deals with the occurrence and distribution of water over and under earth's surface. It is helpful for managing the water resources. 1 mark for each bit

(ii) **Surface runoff:**

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

Run-off can be possible only when the rate of precipitation is more than rate of absorption of water in soil and also evaporation losses.

Run-off = Total precipitation – total evaporation of water

The collection of water in lake, river and ocean depends upon the surface run-off.

(iii) **Evaporation:**

It is the transfer of water from liquid state to vapor state. It includes all the rainfall that is returned to atmosphere from the land and water surfaces.

(iv) **Precipitation:**

Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. It is the primary connection in the water cycle that provides for the delivery of atmospheric water to the Earth. It is mainly of two types:

- a) Liquid precipitation (Rainfall)
b) Solid precipitation (Snow, Hail)

6f) State the function of following with respect to hydro power plant :

- I) Storage reservoir II) Surge tank
II) Spillways IV) Trash rack

Ans:

I) **Storage reservoir:** It is the basic requirement of hydroelectric plant. Its purpose is to store water which may be utilized to run the prime mover to produce electrical power. A reservoir stores during rainy season and supplies the same during the dry season. It can be either natural or artificial. 1 mark for each bit

II) **Surge tank :** A surge tank is the small reservoir or tank. It is open at the top. It is installed near valve house of turbine. It avoids water hammer effect when load on turbine reduces. (It stores immediately the rejected water). It avoids cavity effect when load on turbine increases as it supplies the water immediately.

III) **Spillways:** Acts as a safety valve 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 spill way avoids



damage of dam due to excess pressure of water.

- IV) **Trash rack:** The purpose of providing trash rack is to prevent entry of debris which might damage the turbine runners or choking of nozzles of impulse turbines. It is made of steel bars and is placed across the intake.