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 may try to 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 may give credit for any equivalent figure/figures 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 (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

1 Solve any ten of the following: **20**

1 a) State the various renewable energy sources of electrical energy.

Ans:

Renewable energy sources of electrical energy:

1) Solar energy
2) Wind energy
3) Hydro energy
4) Ocean energy:
   (i) Ocean tidal energy
   (ii) Ocean wave energy
   (iii) Ocean thermal energy
5) Bio energy:
   (i) Bio-fuels
   (ii) Bio-mass
   (iii) Bio-gas
6) Geothermal energy
7) Fuel cells

½ mark for each of any four = 2 marks

1 b) List four thermal power stations in Maharashtra with their location and capacity.

Ans:

	Name of power station / Location	Capacity in MW
1	Koradi	1100
2	Nashik	910
3	Chandrapur	2340
4	Parali	1130
5	Bhusawal	920
6	Paras	500
7	Khaparkheda	1340
8	Tata (Trombay)	1400
9	Dahanu (Thane)	500
10	Wardha	135
11	Amaravati	2700
12	Jindal (Ratnagiri)	1200

½ mark for each of any four = 2 marks

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

Ans:

Factors governing selection of site for thermal power station:

i) Distance from coal mines.
ii) Availability of water.
iii) Availability of land.

iv) Easy access.
v) Cost of land.
vi) Condition of soil.
vii) Distance from populated area or load centre.
viii) Availability of labour.

½ mark for each of any four = 2 marks

1 d) State the terms: i) Hydrology, ii) Precipitation related to power plant.

Ans:

(i) Hydrology:

It may be defined as the science which deals with the depletion and replenishment of water resources. 1 mark

(ii) 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: 1 mark

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

1 e) List the turbines used in hydro power plant on the basis of water head.

Ans:

Turbines used in hydro power plant on the basis of water head:

	Turbines	Water head
1	Impulse Turbine • Pelton wheel	High head 150m to 300m
2	Reaction Turbine • Francis turbine • Kaplan turbine	Low or medium head 60m to 150m Below 60m

1 mark

1 mark (any one)

1 f) State the four properties of fuel used in nuclear power plant.

Ans:

Properties of fuel used in nuclear power plant:

Particulars	Uranium	Thorium
Density	19.13 gm/cm^3	11.71 gm/cm^3
Melting Point	1133±1°C	1690±10°C
Boiling Point	3900°C	3000°C
Electrical resistivity	2 – 4 x 10^4 μΩ-cm	18 μΩ-cm at 20°C
Thermal conductivity	0.062 cal/cm.sec at 75°C 0.078 cal/cm.sec at 400°C	0.108 cal/cm.sec at 65°C 0.09 cal/cm.sec at 800°C

½ mark for each of any four = 2 marks

1 g) State the term 'Nuclear shielding' in NPP.

Ans:

Nuclear shielding:

Thick layers of lead or concrete are provided round the reactor for stopping the gamma rays. Thick layers of metals or plastics are sufficient to stop the alpha and 2 marks

beta particles. The layers used to prevent the harmful rays or particles from coming out of reactor, is called Nuclear shielding. Thus nuclear shielding protects the working personnel from exposure to radioactivity.

1 h) State the function of 'Exhaust System' in diesel electric power plant.

Ans:

Function of 'Exhaust System' in diesel electric power plant:

The function of exhaust system is to discharge the engine exhaust to the atmosphere outside the building. A good exhaust system should keep the noise at low level, exhaust well above the ground level to reduce the air pollution at breathing level and should isolate the engine vibrations from the building by using a flexible section n of exhaust pipe. — 2 mark

1 i) Define the terms used in system operation:
(i) Firm power
(ii) Spinning reserve

Ans: — 1 mark for each definition

(i) Firm power:
It is the power which should always be available even under emergency conditions.

(ii) Spinning Reserves:
It is that reserve generating capacity which is connected to the bus and is ready to take the load.

1 j) Name any two advantages of state level interconnection of power stations.

Ans:

Advantages of state level interconnection of power stations: — 1 mar for each of any two

1) Reduced overall installed capacity.
2) Better utilization of hydro power.
3) Reliability of supply.
4) High unit size is possible.
5) Improved quality of voltage and frequency.
6) Exchange of peak loads.
7) Use of older plants.

1 k) Write formula for solar constant.

Ans:

Solar Constant is given by,

$$I_{SC} = \frac{I_{ext}}{\left[1.0+0.033\cos\left(\frac{360n}{365}\right)\right]} w/m^2 \quad \text{OR} \quad I_{SC} = I_{ext}\left[\frac{R}{R_{av}}\right]^2 w/m^2$$ — 1 mark for equation

where, I_{ext} is the extraterrestrial radiation.
R_{av} is the mean distance between the sum and the earth.
R is the actual sun-earth distance
n is the no. of days from first January. — 1 mark for terms used

1 l) State the limitations of wind energy (any four).

Ans:

Limitations of wind energy: — ½ mark for each of any four

1) Wind turbine produces noise.
2) Its efficiency is less (20% to 30%)

3) There is limitation on site selection. = 2 marks
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.

2 Solve any four of the following: 16

2 a) State any four comparisons between solid, liquid and gaseous fuels used for electrical energy generation.

Ans:

Comparisons between solid, liquid and gaseous fuels:

Particulars	Solid fuels	Liquid fuels	Gaseous fuels
Sources of energy	Lignite coal Bituminous coal Anthracite coal	Heavy oil, Diesel, Petrol, fuel oil, Naptha, High speed diesel, Low Sulpher Heavy Stock (LSHS), Liquefied petroleum Gas (LPG),	Natural gas, manufactured gas
Transportation	Easy	Easy but with more care	Easy but with much care
Ash disposal	Required	Not required	Not required
Economy	Cheap	Costly	More costly
Calorific value	Lignite: 5000kcal/kg Bituminous coal: 7600kcal/kg Anthracite coal: 8500kcal/kg	Heavy oil: 11000kcal/kg Diesel: 11000kcal/kg Petrol: 11110kcal/kg	Natural gas: 520kcal/m^3 Coal gas: 7600kcal/m^3
Weight	Higher	Comparatively less	Much less
Volume required	Higher	Less	Much lesser

1 mark for each of any four = 4 marks

2 b) State the importance of electrical power in day to day life in India.

Ans:

Importance of electrical power:

1) Electrical energy is the basic necessity for domestic, commercial, industrial, agricultural consumers, transport (electric trains), battery operated vehicles etc.
2) Electricity is also basic necessity for economic development of a country. In fact, advanced country is measured by the index per capital consumption of electricity. If it is more, the country is advanced.
3) Electricity is used for various purposes such as,
   i) Lighting, heating, cooling and other domestic appliances
   ii) Street lighting, flood lighting, office building lighting and powering

2 marks for each of any two points

to PCs etc.

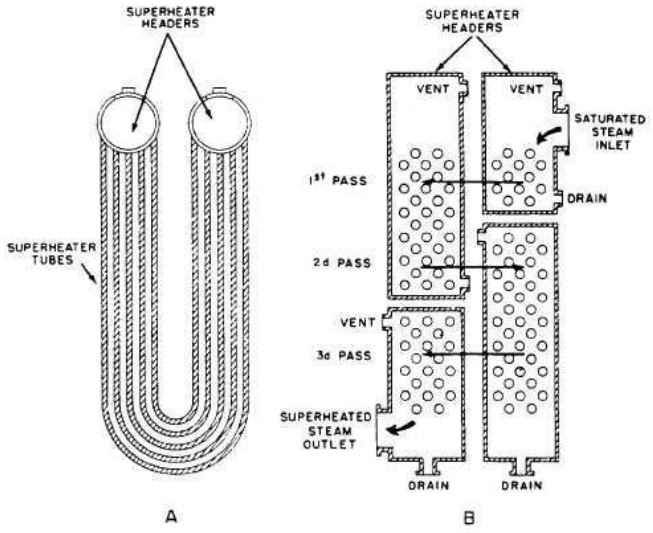
iii) Irrigation purpose, operating cold storage, for various agriculture products.

iv) Running motors, furnaces of various kinds in industry, running locomotives (electric train)

2 c) Draw a neat sketch of super-heater and state their functions.

Ans:

Superheater:



2 marks for diagram

Super-heater is an arrangement to remove the moisture from the wet steam and to convert it into dry superheated steam. Figure shows the super-heater in which the wet steam enters in to the inlet header of the super-heater. Then it passes through the U-shaped tubes the super-heater the next header. This header is called the first pass or intermediate header. Steam may pass through the U-shaped tubes several times before passing to the outlet header. Each time the steam goes from one header to the next header, it is called a pass and during that it is reheated. The number of passes the steam makes in a super-heater varies with different boilers and the degree of superheat that is required.

Functions: 2 marks for functions

The steam produced in the boiler is impure i.e it contains some moisture in it. 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 d) State any four salient features of turbo alternator. Where it is used?

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.

3 marks any four features

5) Field poles are less, 2 or 4.

Use: 1 mark for use

In electrical power generation, turbo alternators are coupled to steam turbines which run at very high speeds.

2 e) State the location and function of the following elements used in hydel plant.
(i) Fore bay (ii) Spillway (iii) Penstock (iv) Tail Race

Ans:

(i) Fore bay:
The fore bay serves as regulating reservoir, storing water temporarily when load on the plant is reduced. It provides water in the event of increasing load, during which time water in the canal is being accelerated. Fore bay may be a pond behind the diversion dam or an enlarged section of canal spread out to accommodate the required width of intake. 1 mark

(ii) Spillway:
This may be considered as a sort of safety valve for a dam. A spillway serves to discharge excess water in the reservoir beyond the full permissible level. 1 mark

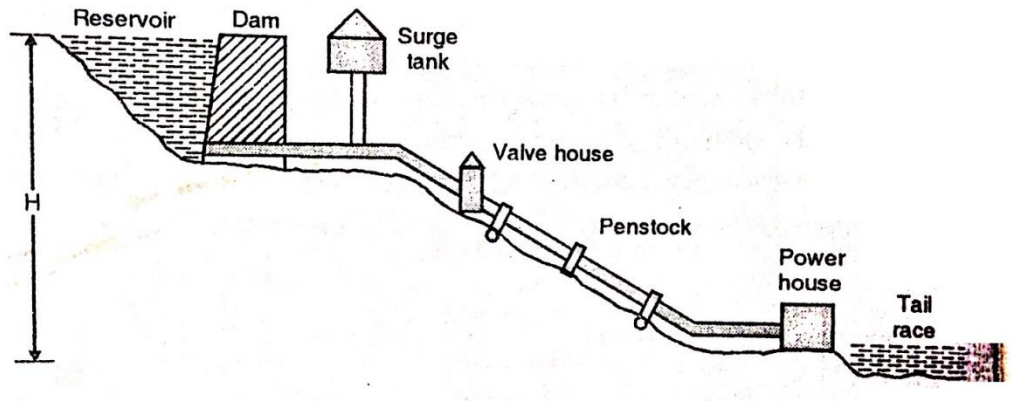
(iii) Penstock:
It is a conduit pipeline. Its function is to carry water from the reservoir to turbine. 1 mark

(iv) Tail Race:
Tail race is nothing but free exit of water and an unimpeded passage to the jet of water leaving the turbine. The water after running the turbine is to be discharged into the river or another dam. For this purpose, a tailrace is required. 1 mark

2 f) Draw a schematic diagram of hydro power plant and label it.

Ans: 4 marks for Labeled diagram

Hydro power plant:



3 marks for partially labeled diagram

2 marks for unlabeled diagram

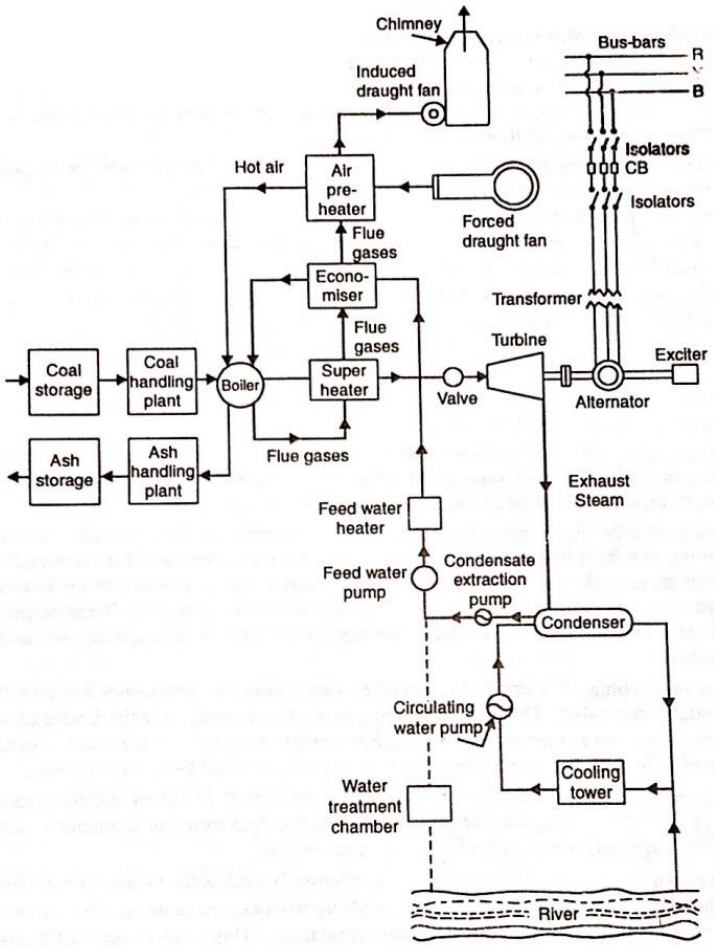
3 Solve any four of the following: **16**

3 a) Draw a schematic block diagram of coal fired P. S. label each block.

Ans:

Equivalent

Diagram be accepted



Schematic arrangement of Steam Power Station

4 marks for Labeled diagram

3 marks for partially labeled diagram

2 marks for unlabeled diagram

3 b) Explain the working of natural draught and forced draught in thermal P.S.

Ans:

Draught: It is defined as the difference between the absolute gas pressure at any point in a gas flow passage and the ambient (same elevation) atmospheric pressure. Draught, being pressure difference, causes the flow of air or gas to take place. Draught can be created by following ways:

Natural Draught:

It is obtained with the use of tall chimney. Natural draught is created by the difference in weight of a column of cold external air and that of a similar column of hot gases in the chimney. The draught is dependent upon the height of chimney and average temperature of the gases in the chimney. It does not use any external power to create the draught. No fans are used. This type of system is useful for small capacity boilers. — 2 marks

Forced Draught:

In forced draught system, the fan installed near the boiler base supplies the air at a pressure above that of atmosphere and delivers it through air duct to the furnace. Thus the draught system supplies forced air for combustion process in furnace. The combustion becomes fast and efficient. — 2 marks

3 c) Explain pumped storage power plant with the help of neat diagram.

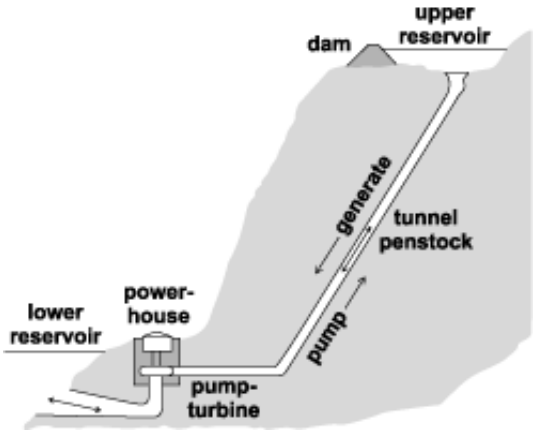
Ans:

Pumped storage Hydro power plant:

These power plants are used when quantity of water availablr 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:

2 mark for diagram

2 marks for explanation



1) Separate arrangement for pumping back the water: In this case separate pumps are used to lift the water from lower reservoir to upper reservoir.
2) 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 electricitiy generation during peak period and same water is reused.

3 d) State the classification of hydro power plants based on load, water head available.

Ans:

Classification of hydro power plants:

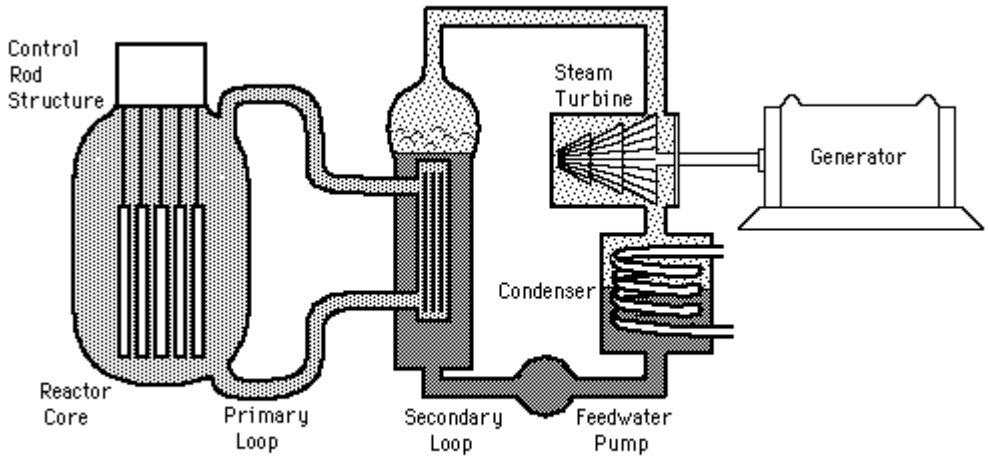
1) Based on Load:
   - i) Base Load Plants: These plants take up load on the base portion of load curve. These plants generally have large capacity.
   - ii) Peak Load Plants: These plants are used to supply the peak load of the system corresponding to the load at the top portion of the load curve.
   - iii) Pumped Storage Plants for Peak Loads: These plants are used to supply peak loads by using water which is pumped back from tailrace during off-peak periods. Reversible turbine – pump unit is used.

2 marks

2) Based on Water head available:
   - i) Low Head Plants: These plants are designed to operate on head below 30m.
   - ii) Medium Head Plants: These plants are designed to operate on head in the range from 30m to 300m.
   - iii) High Head Plants: These plants are designed to operate on head above 300m.

2 marks

3 e) Draw a neat sketch of Pressurized Water Reactor (PWR).
Ans:



Pressurized Water Reactor (PWR)

Labeled diagram 4 marks

Partially labeled diagram 2 marks

Unlabeled diagram 1 mark

3 f) Sate the function of moderator in NPs.
Ans:
Function of moderator in Nuclear Power Stations:

i) Moderator is a medium that reduces the speed of fast neutrons, thereby turning them into thermal neutrons capable of sustaining a nuclear chain reaction involving uranium-235 or a similar fissile nuclide.
ii) The moderator slows down the neutrons before they bombard the fuel rods.
iii) It maintains the fission chain reaction by slowing down the neutrons.
iv) It does not absorb the neutrons.

4 marks for valid function

4 Solve any four of the following: 16

4 a) State the various causes for the less efficiency of thermal power plant.
Ans:
Causes for the less efficiency of thermal power plant:
The overall efficiency of thermal power station (TPS) is quite low (about 29%). It 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 as total losses in TPS is 71%.

a) Boiler House Losses = 16% — 2 marks
Flue gases (5%), Moisture in gases (5%), Remedial and leakage losses (2.5%), Unknown losses (2.5%), Ash (1%).
b) Turbine losses = 54% — 1 mark
c) Electrical loss = 1% — 1 mark

Thus total losses in TPS are 71%, hence its efficiency is less.

4 b) State the location and function of the following elements in thermal P.S.
i) Economizer ii) Ash precipitators.
Ans:
1) Economizer:

Location: Located between super-heater and air preheater. 1 mark

Function: It extracts the heat from flue gases and utilizes this heat to raise the temperature of boiler feed water, so that efficiency of system is increased. 1 mark

2) Ash Precipitators:

Location: Near to the combustion chamber 1 mark

Function: To trap and remove dust / ash particles from the flue gases in TPS. 1 mark

4 c) State the factors governing selection of site for hydroelectric power plant.

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.
2) Storage of water: Sufficient space should be available to collect the water during high flow period (rainy season) and use it throughout the year.
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) Slit and debris (unwanted solid particles): The catchment area should be such that there are less accumulation of slit and debris.
11) Water pollution: Water should be free from chemical impurities.

½ mark for each of any 8 points

4 d) State the harmful disposals which will come out in NPS. How they have been disposed?

Ans:

Harmful disposals of NPS:

The waste products by nuclear fission may be solid, liquid or gas. 1 mark

i) Solid harmful disposals are packaged as required and shipped to a burial site for disposal. 1 mark

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 then released to environment. 1 mark

iii) Gaseous wastes are filtered, compressed to take up less space and then 1 mark

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.

4 e) State the terms related to atomic physics used in NPS.
i) Nuclear chain reaction and
ii) Critical size.

Ans:

i) Nuclear chain reaction:

Self-sustained fission reaction is known as nuclear chain reaction.

OR

When slow moving neutron is bombarded on fuel rods, it splits the atom in to electrons and 2-3 neutrons. Each fissioned nucleus ejects 2-3 neutrons which can again hit uranium nucleus and accelerate splitting process. While separating the electrons, energy is released by atom. If this process continues then it is known as chain reaction. 2 marks

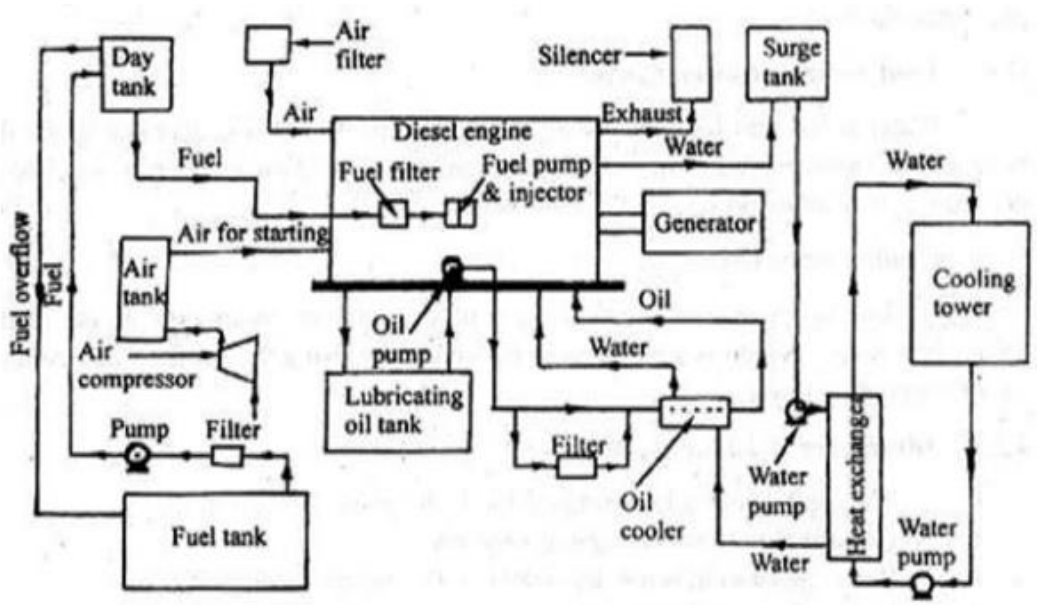
ii) Critical Size:

It is the minimum size of nuclear reactor core which can be made for a specific geometrical arrangement and material composition. It should include enough fissionable material to reach critical mass. 2 marks

4 f) Draw a complete layout of diesel electric power plant showing all the important parts and label it.

Ans:

Layout of diesel electric power plant:



Labeled diagram 4 marks

Partially labeled diagram 2 marks

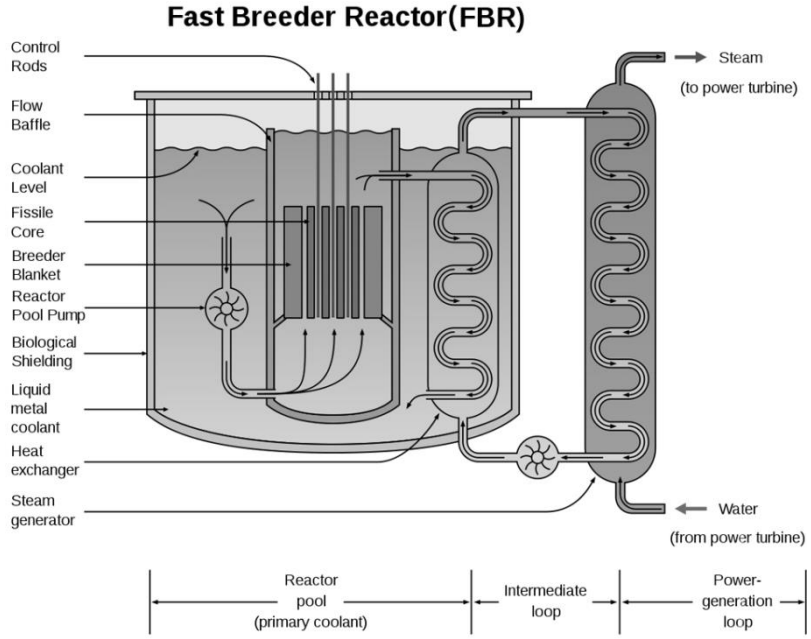
Unlabeled diagram 1 mark

5 Solve any four of the following: 16

5 a) Draw and explain the operation of Fast Breeder Reactor (FBR).

Ans:

Fast Breeder Reactor (FBR):



2 marks for diagram

A fast breeder reactor produces heat and at the same time converts fertile material into fissible material. The central portion of this reactor is a stainless steel pot in which a core of fissible material is kept. The Fuel used is natural or enriched Uranium. This core of fissible material is surrounded by a blanket of breeder (fertile) material (U238 or Th232). 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 (Pu239 or U233). 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.

This type of reactor is also called as liquid metal cooled fast breeder reactor (LMFBR), there are two types of designs: 1) Pool design and 2) Loop-design.The figure shows “Pool” design.

5 b) How nuclear reactor can be controlled by using control rods and through flow of coolant?

Ans:

Nuclear reactor control using control rods:

Control rods are made up of very high neutron absorbing material like boron, cadmium. By adjusting height of control rods in reactor core according to requirements we can control the chain reaction. When control rods are pushed in deep in core then control rod absorbs almost all neutron in the fission process,

2 marks

stopping chain reaction automatically. However, when control rods are withdrawn, then more and more neutrons cause fission process and hence intensity of chain reaction (heat produced) increases.
Therefore by putting in or out the control rods, power of nuclear reaction can be controlled.

Nuclear reactor control using coolant:

Coolant is medium through which the heat liberated in reactor is transferred to the heat exchanger for generation of steam. If coolant, having neutron absorbing property, is used, it will absorb neutrons in some extend and due to this nuclear reactor can be controlled. 2 marks

5 c) State types of captive power plant. Explain any one for power generation.

Ans:

Types of captive power plants:

i) Diesel power plant
ii) Wind power plant
iii) Solar power plant
iv) Thermal power plant (small size)

1 mark for types

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. 3 marks for explanation of any one

Diesel power plant as captive power plant:

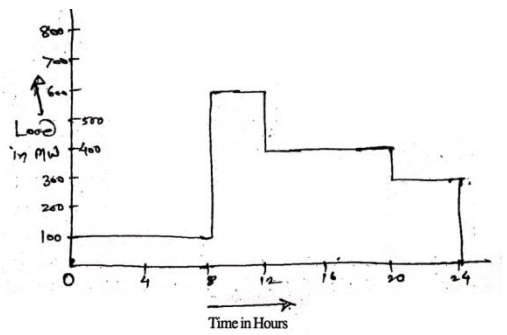
In case of diesel power plant power generation is carried by using diesel as fuel for diesel engine coupled to generator. It is installed near load centre. It requires less space. As it has minimum starting and stopping time, it can be turned on and off quickly as per the availability of grid supply. Also it can be synchronized with grid for excess power feeding to the grid.

Solar power plant:

Roof-top solar photovoltaic system can be operated as captive power plant. During sunny day when the photovoltaic system operates efficiently, the generated power can be used to meet the owner's demand. If excess power is available even after meeting the owner's demand, it can be fed to the grid at higher rate to earn money or to earn unit credit. Also the excess power can be stored in batteries for use during night hours.

5 d) The daily load curve of a P.S. is shown in figure 5(d). Find:

i) M.D. on the P.S.
ii) Units generated per day
iii) Load factor
iv) Average load



Ans:

i) M.D. on the power station:

Maximum Demand = 600 MW. 1 mark for each bit

ii) Units generated per day = Area under daily load curve
= (100x8) + (600x4) + (400x8) + (300x4)
= 7600 MWh

iii) Average load$= \frac{Energy\ consumed\ in\ 24\ hrs}{hours\ of\ a\ day} = \frac{7600}{24} = 316.667\ MW$

iv) Load factor $= \frac{Average\ load}{Maximum\ demand} = \frac{316.667}{600} = 0.527$

5 e) With the help of schematic diagram explain the direct ~~distribution~~ utilization of solar energy.

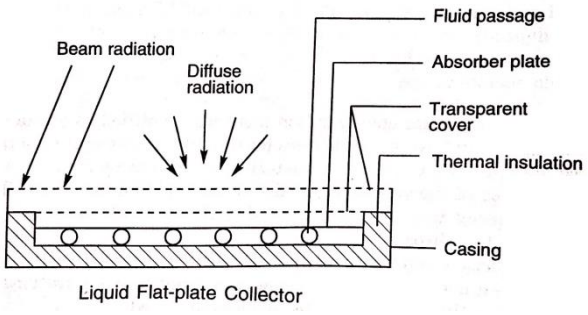
Ans:

Direct ~~distribution~~ utilization of solar energy:

The energy from the sun can be used directly or indirectly. The direct means include thermal and photovoltaic conversion, while the indirect means include the use of water power, the winds, biomass, wave energy and the temperature difference in the ocean. **Any one**

1) Thermal Conversion:

The figure shows one arrangement for making use of solar energy for thermal applications. It shows a schematic diagram of a liquid flat-plate collector to heat up the water. It consists of an absorber plate on which the solar radiation falls after coming through one or more transparent covers (glass). The absorbed radiation is partly transferred to a liquid flowing through tubes which are fixed to the absorber plate or are integral with it. The remaining part of the radiation absorbed in the absorber plate is lost by convection and re-radiation to the surroundings from the top surface and by conduction through the back and the edges. The transparent covers help in reducing the losses by convection and re-radiation, while thermal insulation on the back and the edges helps in reducing the conduction heat loss. Due to received solar energy, the liquid, usually water get heated, which can be used for domestic purposes. Thus the solar energy is directly used.



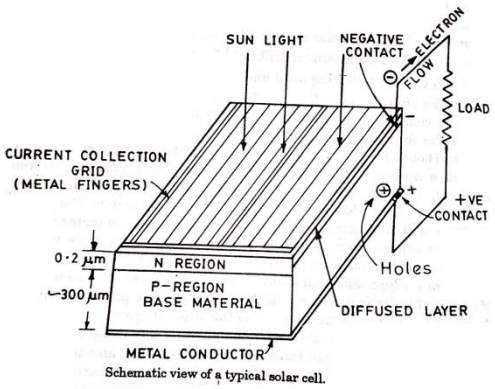
Liquid Flat-plate Collector

2 marks for diagram

2 marks for explanation

2) Photovoltaic Conversion:

Photovoltaic effect is defined as the generation of the emf as a result of the absorption of ionizing radiation. Energy conversion devices used to convert sunlight in to electricity by the use of photovoltaic effect, are called "solar cells" or more generally "photovoltaic cells". These



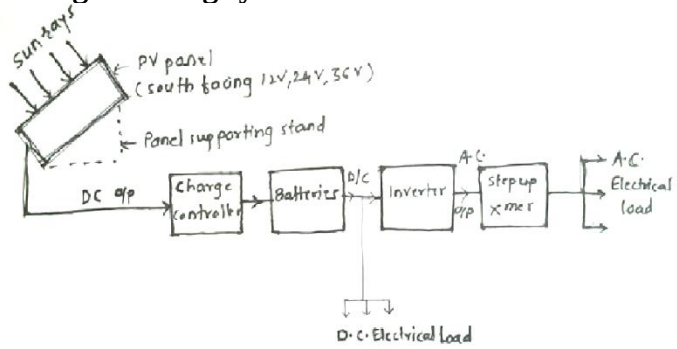
Schematic view of a typical solar cell.

are made of semiconductors that generate electricity when they absorb light. When photons from the sun are absorbed in a semiconductor, they create free electrons with higher energies than the electrons which provide the bonding in the base crystal. There must be an electric field available to force these electrons to flow out of the semiconductor to do useful work. This electric field is provided in most solar cells by a junction of materials which have different electrical properties. Thus continuous radiation from sun generates electricity in semiconductor junction. The figure shows schematic view of a typical solar cell.

5 f) With the help of functional block diagram, explain photovoltaic power generating system.

Ans:

Photovoltaic power generating system:



2 marks for block diagram

Photovoltaic power generating system 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. 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 convert DC supply into AC supply..
5. **Step-up transformer:**
   It step-up input voltage to utilization voltage e.g. 230V.

2 marks for explanation

6 Solve any four of the following: 16

6 a) State the advantages and disadvantage of diesel power plants.

Ans:

Advantages of Diesel 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 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 responses for variable load.
16) The size of diesel engine plant is small compared to the steam plant for the same capacity of generation.

½ mark for each of any four = 2 marks

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 electric 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.

½ mark for each of any four = 2 marks

6 b) The generating station has a 0.7 load factor with a 0.5 plant capacity factor and a 0.8 plant use factor. Maximum demand of the generating station is 30MW. Calculate: (i) Energy produced per day (ii) Max. energy produced per day if the plant was running all the time.

Ans:

Data Given: Load factor = 0.7
Plant capacity factor = 0.5
Plant use factor = 0.8
Maximum demand MD = 30 MW

Energy generated per day

$$= (Max.Demand \times load\ factor) \times No.of\ hours\ in\ a\ day$$
$$= (300 \times 0.7) \times 24$$
$$= 5040\ MWh$$

2 marks

Maximum energy produced if plant is running all the time

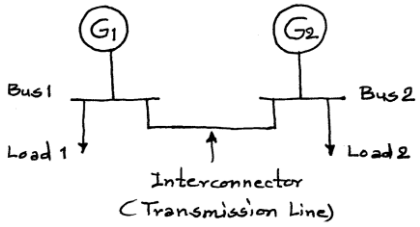
$$= \frac{Actual\ energy\ produced}{Plant\ capacity\ factor} = \frac{5040}{0.5}$$
$$= 10080\ MWh$$

2 marks

6 c) Explain the process of load sharing between interconnected power stations.

Ans:

Process of load sharing between interconnected power stations:



2 marks for diagram (equivalent accepted)

Consider two generating Station G_1 and G_2 interconnected to each other through an inter connector (a transmission line). The generators G_1 and G_2 are so scheduled as to keep the generation cost per unit minimum. The power flow through interconnector depends upon the bus voltages. Thus total load is shared with economical generation till any one generator reaches to its rated capacity. Then the load sharing of that generator is maintained fixed to its rated capacity, while the other generator takes the additional load. Thus during load sharing, the power transfer through the interconnector take place according to the requirement of economical generation.

2 marks for explanation

6 d) State main components of wind power plant and state their functions.

Ans:

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.

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 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) Brakes:

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, 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.

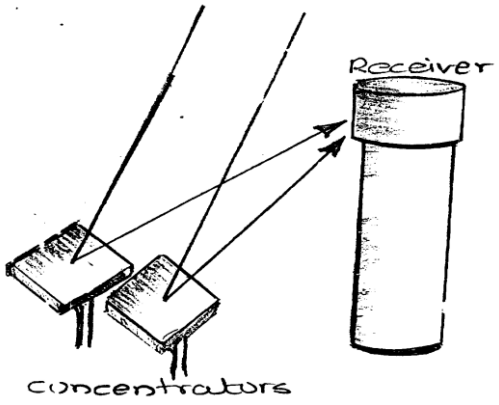
½ mark for any 8 components with function = 4 marks

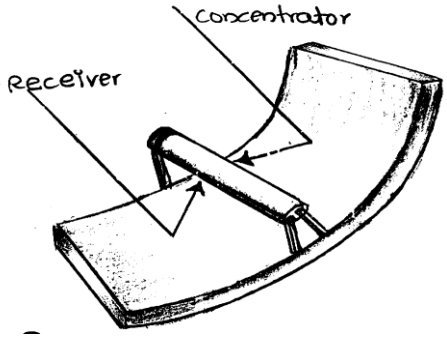
7) Yaw Controller:
It brings the blades towards the face into the wind direction i.e. it detects the direction of wind. It performs the task of orienting the rotor in the direction of wind.
8) Pitch Controller:
The pitch controller adjust automatically the pitch of each blade i.e. blade can be rotate 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 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. 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.

6 e) Draw concentrating type of collector and state their two demerits.

Ans:

Concentrating type of collector:





Any one equivalent diagram 2 marks

Merits of Concentrating type of collector:

1) The area intercepting the solar radiation is greater.
2) Much higher temperatures can be obtained.

1 mark for each of any two merits.

3) Can be used to generate medium pressure steam.
4) Efficiency is better.
5) Heat losses are reduced.
6) Less cost per unit area of solar collecting surface.

6 f) State various types of wind turbines. Draw horizontal axis wind turbine.

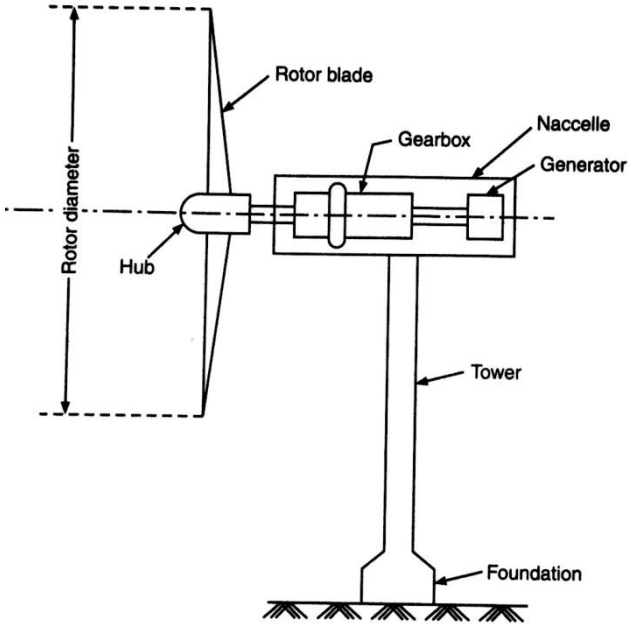
Ans:

Types of wind turbines :

i) Horizontal axis wind turbine
ii) Vertical axis wind turbine.

1 mark for types

Horizontal axis wind turbine:



Horizontal Axis Wind Mill

3 marks for diagram