Important Instruction 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) List any four sources of conventional energy.

Following are the conventional energy sources.

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

1. Thermal power plant
2. Nuclear power plant
3. Hydro power plant
4. Diesel power plant

b) List any two hydroelectrical power stations in Maharashtra with their installed capacity.

Hydro-electric power stations in Maharashtra:- Student may write different location may be consider while giving mark. (Any two of the following expected -1 mark for each)

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

c) State the function of chimney and superheater in thermal power station.

1. Function of Chimney: **(Each Function 1 Mark)**

Flue gases (smoke) are produced during combustion process. These flue gases produce air pollution, SO to reduce air pollution it should be passed in air as high as possible with the help of Chimney.

2. Function of Super heater:

Its function is to remove the moisture from the steam leaving the boiler and also to increase its temperature above the saturation temperature.

For this purpose heat energy of exhausted flue gases from the furnace is utilized.

d) State the main components of Nuclear Power station.

(At least four component expected each component 1/2 Mark)

Main Components of Nuclear power Plant:

i) Nuclear Reactor
ii) Heat exchanger
iii) Coolant circulating System
iv) Condenser Plant
v) Steam value
vi) Steam Turbine
vii) Alternator

e) Give Classification of diesel engines. **(Each Type 1 Mark)**

Classification of Diesel Engines:

i) Two Stroke Diesel Engine
ii) Four Stroke Diesel Engine

f) List the major locations of wind mills in Maharashtra. **(2 Mark)**

Locations of Wind Mills in Maharashtra: - (At least four location expected each location 1/2 Mark) Student may write different location may be consider while giving mark.

S.No	Location
1	Gudepaachgani (Sangli)
2	Panchgani (Satara)
3	Chalkewad (Satara)
4	Thosghav (Satara)
5	Kotoli (Kolhapur)
6	Devgad or Deogad (Sindudurga)
7	Vankusawade (Near koyna)
8	Vashpet (Sangli)

g) State two important drawbacks of hydroelectric power stations. (At least Two Drawbacks expected each drawbacks 1 Mark)

Important drawbacks of hydroelectric Power Stations:- (Expected any two 1 Marks each)

1. High capital cost due to construction of dam.
2. It depends on nature as it require huge amount of water which is store during rainy season.
3. Firm power (Out put) is totally depends on monsoon.
4. It takes long time for complete erecting of power plant.
5. It requires large area (catchment) area for storage of water.
6. As sites are away from load centre, so cost of transmission and losses in it are more.
7. There is limitation to select the site of HPP because of their requirements.

h) Why the power stations are connected with each other. **(2 Mark)**

Because of following advantages power stations are connected with each other: (At least four points expected each point 1/2 Mark)

i) Reduced Overall installed Capacity:-

Inter connected power systems reduce the overall requirement of installed capacity. With interconnection between power systems, peak demand in an area is meet by importing

power from neighboring area. Thus, it also reduces investment and fulfills the peak demand.

ii) Better Utilization Hydro Power:-

In combined power system, hydro power can be utilized in more effective way. during rainy season, hydro power plant can be utilized, while during draught periods, steam power plant can be used as base load plant.

iii) Reliability of Supply:-

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

iv) High unit size possible:-

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

v) Improved quality of voltage and frequency:-

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

vi) Exchange of peak loads:-

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

vii) Use of older Plants:-

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

viii) Insure Economical operation:-

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

ix) Increases Diversity factor:-

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

x) Increases load factor:-

The load factor and efficiency of operation are improved.

xi) Reduces Plant Reserve capacity:-

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

xii) Better utilization of natural resources:

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

i) Define load factor. What is maximum value of load factor? (Each Definition 1 Mark)

Load Factor:

The ratio average demand to the maximum demand during a given period is known as load factor.

$$Load\ Factor = \frac{Average\ \ demand}{Maximum\ \ demand}$$ **OR**

$$Yearly\,Load\ Factor = \frac{No.\,of\ \ units\,(KWH)\ generated\ in\ one\ year}{Maximum\ demand \times Hours\ \ in\,1\ year\ (8760\ hr)}$$

Maximum value of load factor:

Maximum value of load factor is **one**.

j) State the materials used for control rods in nuclear reactor. Mention the function of control rod. **(Material used for control rod- 1 Mark & Function-1 Mark)**

Material used for control rod should have neutron absorbing properties:

i) Boron
ii) Cadmium
iii) Hafnium

Function 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.

k) Define the overall efficiency of thermal power station. **(2 Mark)**

Overall Efficiency of Thermal power Station:-

(Note: Student may write definition in different way also)

$$\text{Overall efficiency } \eta = \frac{H}{W \times C.V}$$

Where, H= Heat equivalent per KWH

W = Amount of coal consumed per KWh

Cv = Calorific value of fuel

l) What is the difference between cold reserve and hot reserve in connection with generating station? **(2 Mark)**

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

m) What is meant by lake tapping? State the name of power station with which it is connected in Maharashtra State. **(Lake Tapping-1 Mark & Name of P.P- 1 Mark)**

Lake Tapping:-

Lake tapping is a method of blasting an intake into a body of water from below the natural water surface without first lowering that surface or installing a protective cofferdam around the tap hole. Lake taps are done by first excavating a tunnel almost to the water/rock contact and then blasting out the final protective rock plug at one time to allow water to suddenly inflow into the tunnel from the lake. This procedure can be done "dry" or "wet." In the dry method the tunnel is empty of water before the final plug blast while in the wet method it is partially filled with water. **OR**

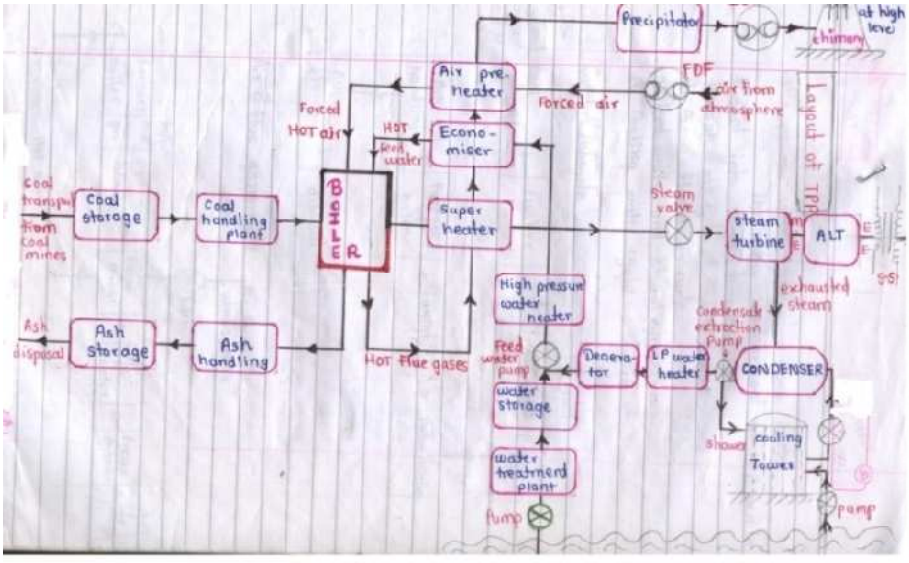
Lake tapping is a method of blasting an intake into a body of water from below the natural water surface without first lowering that surface or installing a protective cofferdam around the tap hole. Lake taps are done by first excavating a tunnel almost to the water/rock contact and then blasting out the final protective rock plug at one time to allow water to suddenly inflow into the tunnel from the lake

The name of power station with which it is connected in Maharashtra State:

Koyna Hydro power plant (Satara)

Q.2 Attempt any Four of the following **16 Marks**

a) Draw a typical layout of a thermal power plant and label it. **(4 Mark)**



or equivalent figure

b) State the factors affecting the site selection of thermal power station. Discuss these in brief. **(Any four point expected-1 Mark each point)**

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

i) Distance from coal mines :-

The power plant should be near the coal mine ,so that cost of fuel transportation reduces.

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) Space availability :-

The power plant should have sufficient large space available for coal storage & ash disposal.

iv) Load Centre :-

Plant should be located near load centre to reduce transmission cost & transmission line losses.

v) Easy acces :-

The site should have easy acces for transportation of machanery, man power, etc

vi) Condition of soil:-

The land should be rocky (Hard murrum) for the better foundation of building and machianry.

vii) 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.

c) What is meant by quality of fuel in connection with thermal power station? State its effect on quality of power generation. **(Difination-2 Marks & Effect – 2 Mark)**

(Note: Student may write answer in different way also)

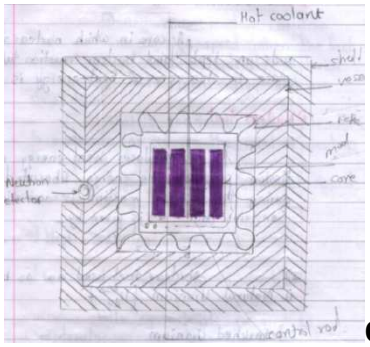
Quality of Fuel:

Quality of fuel means its calorific value that is how much heat energy is produced from a given quantity of fuel.

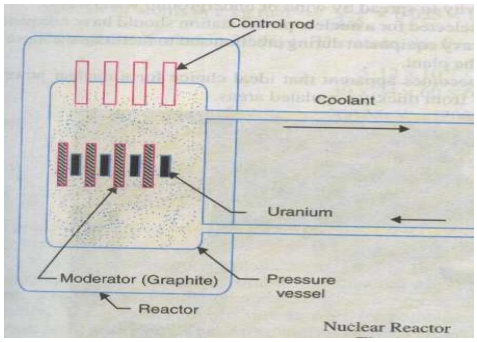
Effect on quality of power generation: - There is **no effect on quality of power generation but,**

- The use of coal with high ash content increases the plant size and transportation cost and reduces the thermal efficiency.
- Fuel consumption increases.
- Steaming time increases.
- Efficiency of Furnace decreases.

d) Draw neat constructional diagram of Nuclear reactor. Label it. State working of it briefly. **(Digaram-2 Marks & Working – 2 Mark)**



OR



or equivalent figure

Working :

It is an appratus in which heat energy is produced due to nuclear fission chain reaction. The energy libreted in the chain reaction is according to Einstein's law and is given by $E = mc^2$ and it consists of following parts. This heat energy is utilise for producing steam in heat exchanger.

e) Define the terms nuclear fission and chain reaction as referred to nuclear power station.

(Each Difination-2 Marks)

Nuclear Fission:

Energy is released without using oxygen for combustion in process is known as nuclear Fission.

Chain Reaction: (Note: Student may write answer in different way also)

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.

f) State 3 Limitations of nuclear power station. Name the nuclear power station in Maharashtra with its installed capacity.(Limitation -3 Marks & Name of N.P.P – 1 Mark)

Limitations of nuclear power station: (Any three Expected)

i) The capital cost NPP is very high as compared to other conventional power plant of same capacity.
ii) Fuel used is very expensive & is very difficult to recover.
iii) The erecting and commissioning of plant requires greater technical knowledge.
iv) It causes radioactive air pollution.
v) Maintenance charges are high because it requires high skill technician.
vi) High salaries of special trained personnel employed to handle the plant.
vii) Nuclear waste disposal cost is high and is a big problem.
viii) The cooling water requirements of NPP are very heavy.
ix) Cooling towers required for NPP are larger & costlier than TPP.
x) This plant is not suitable for variable load.

Name the nuclear power station in Maharashtra with its installed capacity:

i) **Tarapur:** Capacity: 420 MW

Q.3 Attempt any Four of the following **16 Marks**

a) Classify hydroelectric power stations on basis of : i) Head water ii) Quantity of water available **(Each Classification – 2 Mark each)**

Hydro power plants are classified as below:

i) Head of Water :

i) Low head power plant (Below 30m)

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

iii) High head power plant (above 300m)

ii) Quantity of water available :-

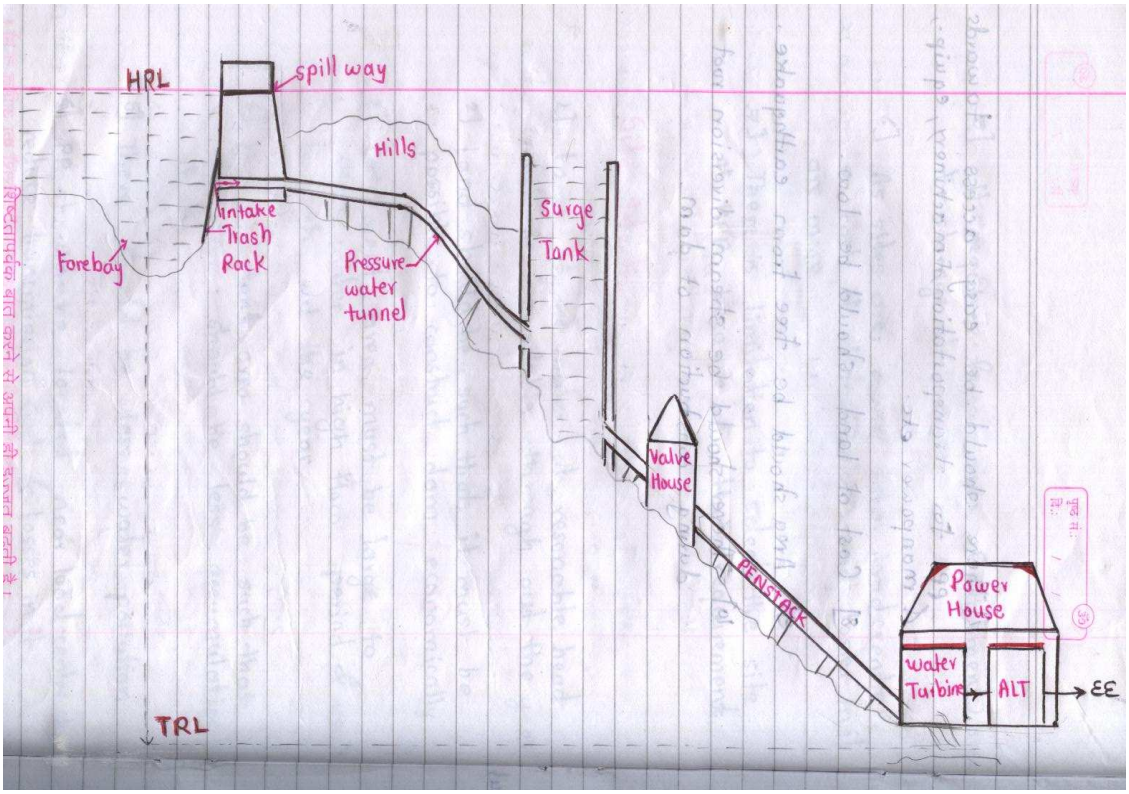
i) Run-off River power plant without poundage

ii) Run-off river power plant with poundage

iii) Large reservoir power plant

b) Draw neat layout of hydro-electric power station. Label it. Explain the operation briefly.

(Diagram- 2 Mark & Operation-2Mark)



or equivalent figure

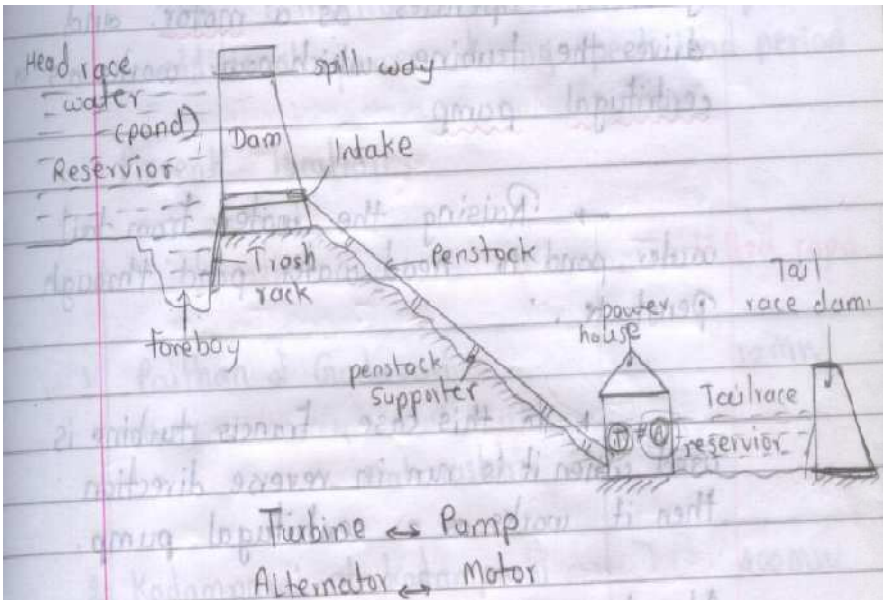
Operation of Hydro- Electric Power Plant:

(Note: Student may write operation in different way also)

Water stored at high level by constructing dam across river. This stored water has potential energy. This stored water is passed to run the water turbine which is located at lower level through penstock.

Thus potential energy of water is converted into kinetic energy in penstock and turbine converts kinetic energy into mechanical energy and Alternator is coupled to water turbine which converts mechanical energy into electrical energy.

c) What are pumped storage plants? Draw a neat labelled sketch of pumped storage plant. State its operation and application. (Digaram-2 Marks, Operation-1 Mark & Application – 1 Mark)



or equivalent figure

Pumped storage hydroelectric power plant & Operation:-

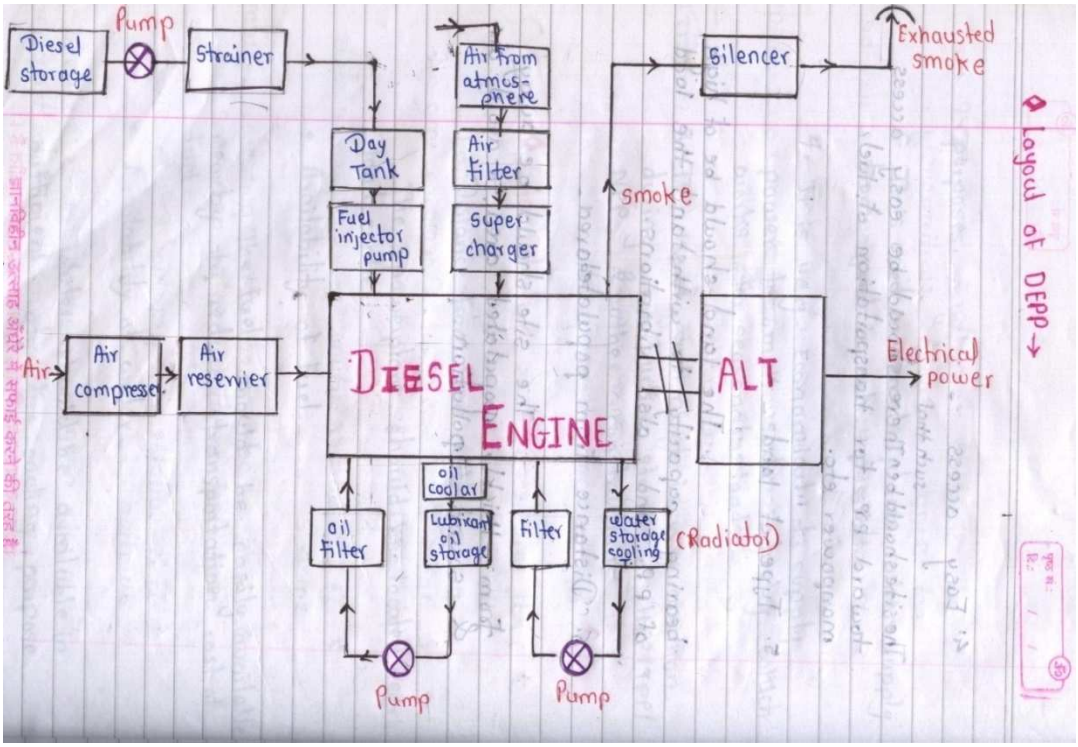
- It consists of **head water pond** (reservoir) and **tail water pond** by constructing a **dam**.
- Tail water pond and head water pond connected through penstock.
- Such plants can be operated only in **interconnected system**, where other generating plants (such as **TPP & NPP**) are available during their off load period.
- During peak hours the turbine drives the generator and generates electrical energy.

- **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.
- In this case, Francis turbine is used

Applications of Pumped storage plants:

i) To supply peak load.

d) Draw the labelled block diagram of diesel power plant. (Diagram – 4 Mark)



or equivalent figure

e) State the meaning of operation, maintenance and trouble of diesel power plant. Give main troubles of diesel power plant and their shooting.

(Operation-1/2 Mark, Maintenance -1.5 Marks & Trouble shooting – 2 Mark)

Operation:

- The condition of operation oil pressure, water pressure, inlet and outlet temperatures of water & oil etc is maintained at regular intervals.

- Correct record of instrument reading ammeter, voltmeter, and wattmeter and energy meter should be taken at regular intervals.
- A separate log sheet is used for keeping record.

Diesel power station maintenance include:-

1. Cleaning of fuel oil from dirt and impurities by means of filters.
2. Occasionally all fuel is drained and fuel tank are cleaned thoroughly.
3. Air filter should be cleaned thoroughly.
4. The temperature and quantity of coolant should be checked.
5. Lubrication & engine oil also should be checked.
6. Temperatures of Exhaust gases are also checked.

OR

Maintenance schedule for Diesel Power plant:

(Note: At least four points should be covered)

S.No	Maintenance	Daily	Weekly	Monthly	Six month	Yearly
1	Check Coolant Heater	✓				
2	Check Coolant Level	✓				
3	Check oil level	✓				
4	Check fuel level	✓				
5	Check charge air piping	✓				
6	Clean air cleaner		✓			
7	Check battery charger		✓			
8	Check drain water from fuel tank		✓			
9	Check coolant concentration		✓			
10	Check drive belt tension			✓		
11	Check starting compressor			✓		
12	Change oil & oil filter			✓		
13	Change coolant & coolant filter				✓	
14	Change crank case breather				✓	
15	Change air cleaner				✓	
16	Check radiator hoses				✓	
17	Change fuel filter				✓	
18	Clean cooling system					✓

Trouble Shooting for Diesel Power Plant:

(Note: At least four points should be covered)

S.No	Trouble (Complaint, problems) causes	Will Not start	Hard to start	Start stalls	Run rough	Lack of power	Black smoke	While Smoke	Shooting
1	Poor Fuel Quality	✓	✓	✓	✓	✓			Change the fuel
2	Air in fuel			✓	✓				Remove the air
3	No fuel to cylinder	✓							Fill the fuel
4	Instticient fuel supply	✓	✓	✓	✓			✓	Clean the fuel supply injectors
5	Fuel Leaks at injection lines				✓				Remove the leakage
6	Some or all injectors bad	✓	✓		✓		✓		Replace by new
7	Air intake restricted					✓	✓		Clean the air filter
8	Low compression	✓	✓					✓	Check & correct
9	Incorrect engine timing	✓	✓				✓		Adjust the timing
10	Incorrect starting procedure	✓	✓						Use correct starting procedure
11	Low cranking speed	✓	✓						Check & correct
12	Internal engine problem	✓	✓			✓	✓		Check & correct

f) State two applications of diesel power plant. How the operation of diesel power plant can be automatic. **(Application -3 Marks & Automatic operation – 1 Mark)**

Applications of Diesel Power Plant: (Any two points expected)

i) It can be used as a standby (emergency) power plant to maintain continuity of supply.

ii) It is suitable where power requirement is small.

iii) It is widely used in transportation system. E.g. Elect. Traction, Ship, Aero plane etc.

iv) It is suitable as a peak load power plant for short duration.

v) Mobile DEPP mounted on vehicle is used in emergency requirement and for temporary purpose.

vi) It is used in remote places where supply from grid is not possible.

vii) It is very economical to supply power to small scale industry which works for seasonal period.

viii) The use of such plant is very common during construction stage of HPP/TPP/NPP and other construction.

Operation of diesel power plant can be made automatically:

When in coming supply to load fails due to any reason then generator will automatically starts after three minutes or preset time for this purpose a separate panel called as **Auto Mains Failure (AMF)** is necessary also when supply restored generator will automatically stop after three minutes or preset time.

Q.4 Attempt any Four of the following **16 Marks**

a) "The non- conventional sources were known to man since early days, still they were not developed" comment and give reasons.

The non- conventional sources were known to man since early days, still they were not developed because of following reason: (Any Four reasons expected 1 Mark each)

i) Initial cost per MW is high.
ii) No firm generating capacity.
iii) Its efficiency is low.
iv) There is limitation on site selection in some cases.
v) Generating capacity is less.
vi) There is no guaranty that power is generated during peak hours or whenever needed.
vii) Power generation is not phase with demand.
viii) Cost per unit is high in some power plant.
ix) It is not reliable.
x) Life is less.

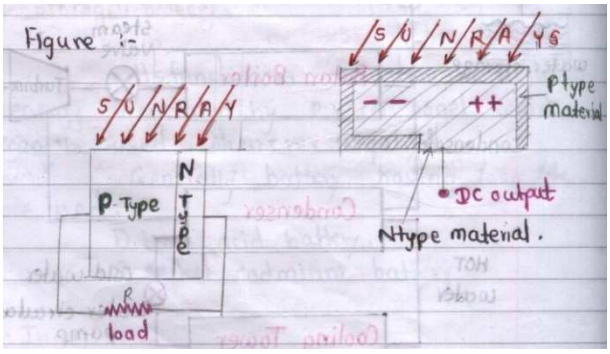
b) What is mean solar cell? State working of solar cell with neat sketch.

(Meaning -2 Marks & Figure – 1 Mark, Working-1 Marks)

Solar Cell:

Which converts solar energy (heat energy) directly into electrical energy (DC) is called as solar cell. **OR**

Silicon solar cell consists of a thin slice of single crystal P-type silicon material upto 2 cm^2 into which a very thin (0.5 micron) layer of N-type material is diffused.



or equivalent figure

Working:-

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

Solar cell works in following steps.

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

OR

Working:-

Photovoltaic cell is small semi conductor device which has light sensitive P-N junction. It made up semi-conducting material and these cells are light sensitive. The p-Type layer is thick while the N-type layer is thin. When trivalent impurity is added, P-type semiconductor is obtained. When sunlight strikes the N-type layer, some of the waves of light energy penetrate up to the P-type layer. When photons from the sunlight energy are absorbed in semi conductor, and sunlight energy is greater than energy gap,

electron-hole pairs are formed. Electrons are released from N-type material and holes are created in P-type material electrical circuit is completed and flow of current takes place.

Photo voltaic cell system converts solar energy directly into electrical energy without any waste products.

c) State the advantages and Limitations of Tidal power generation.

(Advantages -2 Marks & Limitation – 2 Mark)

Advantages of Tidal Power generation: (Any Four Expected)

i) It is clean & free from air pollution.
ii) Fuel is freely available.
iii) No transportation cost on fuel & waste disposal problem.
iv) It does't require any combustion of fuel.
v) It is independent on external fuel supply & fluctuations in existing fuel rate.
vi) It is renewable energy source.
vii) Tidal energy is in exhaustive.
viii) Long Life
ix) Cost per unit is less.
x) It is independent on weather & seasonal condition.
xi) Operation and maintenance cost is less.
xii) No waste of useful land for power plant erecting.
xiii) Tides are totally predictable (both in terms of timing & force)
xiv) Tides can exchange millions of gallons of water in just minutes.
xv) Dam constructed for tidal power plant may protect coast line again damage from high storm tides & provide readymade road bridge.

Limitations of Tidal Power generation: (Any Four Expected)

i) High capital cost due to large length & size of dam.
ii) There is limitation on site selection because it requires minimum tidal range between 5-8 meter.
iii) It provides power only for 10 hours per day.

iv) There is no guaranty that power is generated during peak hours.

v) Design of dam/ barrage is quit complicated.

vi) Power generation is not in phase with demand.

vii) Changing of tidal range in two weeks period produces changing power generation.

viii) It affects marine life of fish, animals & environmental at that location/ coastal life.

ix) It may affect/ abstraction to marine traffic.

x) No firm generating capacity.

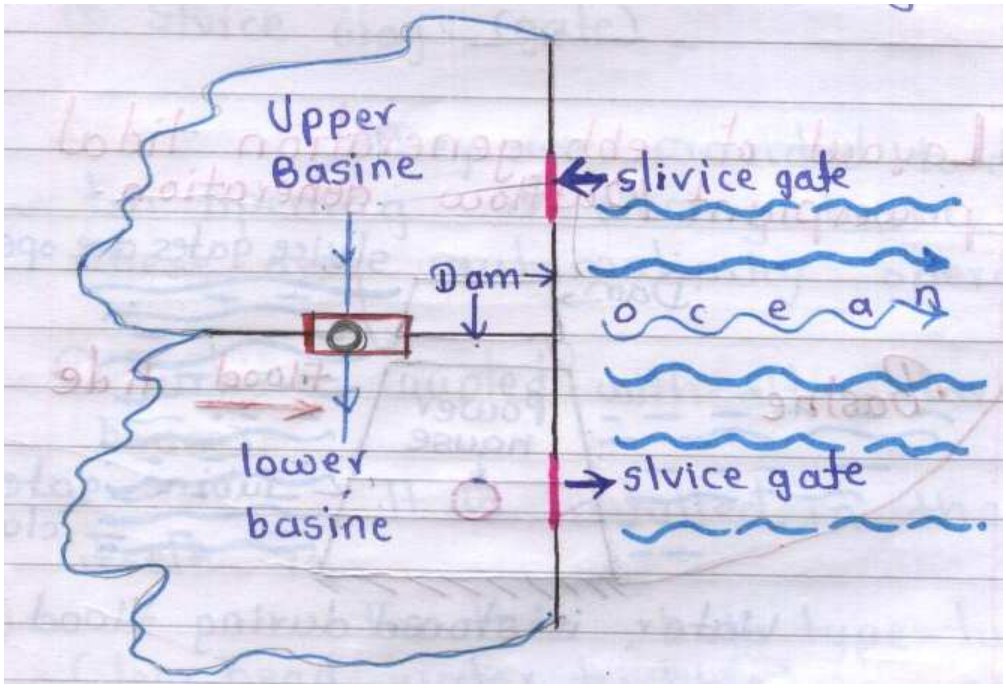
xi) Such power plants are located away from load centre so transmission cost increases.

xii) As water is salted, there is possibility of rusting of equipments.

xiii) Time required for completion of project is more due to construction of dam.

d) Draw the neat sketch of Ocean tidal energy conversion plant. State the limitations of tidal power Generation. **(Any one Diagram is expected-2 Marks & Limitation – 2 Mark)**

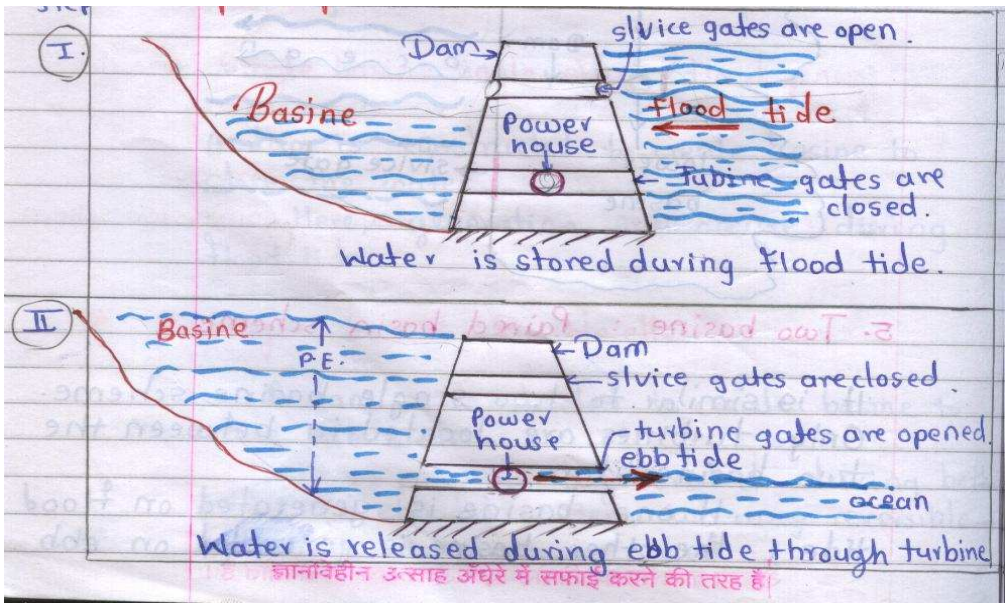
Figure for Two Basine, Linked basine scheme:



OR

or equivalent figure

Layout of Ebb generation Tidal power Plant or out flow generation:-



Limitations of Tidal Power generation: (Any Four Point Expected)

i) High capital cost due to large length & size of dam.

ii) There is limitation on site selection because it requires minimum tidal range between 5-8 meter.

iii) It provides power only for 10 hours per day.

iv) There is no guaranty that power is generated during peak hours.

v) Design of dam/ barrage is quit complicated.

vi) Power generation is not in phase with demand.

vii) Changing of tidal range in two weeks period produces changing power generation.

viii) It affects marine life of fish, animals & environmental at that location/ coastal life.

ix) It may affect/ abstraction to marine traffic.

x) No firm generating capacity.

xi) Such power plants are located away from load centre so transmission cost increases.

xii) As water is salted, there is possibility of rusting of equipments.

xiii) Time required for completion of project is more due to construction of dam.

e) State the factors for selection of site for wind mills. Explain briefly. Mention the speciality of wind mill generator. (Factors for selection wind Mill -2 Marks & Speciality of generator – 2 Mark)

The Factors for selection of site for Wind Mills: (Any Four Point Expected)

i) The site should be selected where winds are strong i.e where pressure of wind is high and there is continuity (10-15km/hr) and above.

ii) It is better to choose a site near the seashore (coastal area)

iii) Winds turbines are also installed OFF shore (in ocean) OFF shore wind turbine generate more electricity than those on land because the wind at sea is typically stronger and more constant than ON shore.

iv) Wind pressure is also high in hilly area so wind turbines are located in hilly area.

v) Site should be convenient for transportation facility.

vi) The cost of land should be low.

vii) Plant must be installed on tall towers (45m to 149 m) as wind pressure is available with higher velocity.

The specialty of wind mill generator:

Note: In this case credit may be given by judgment on part of examiner of relevant answer based on candidate understands.

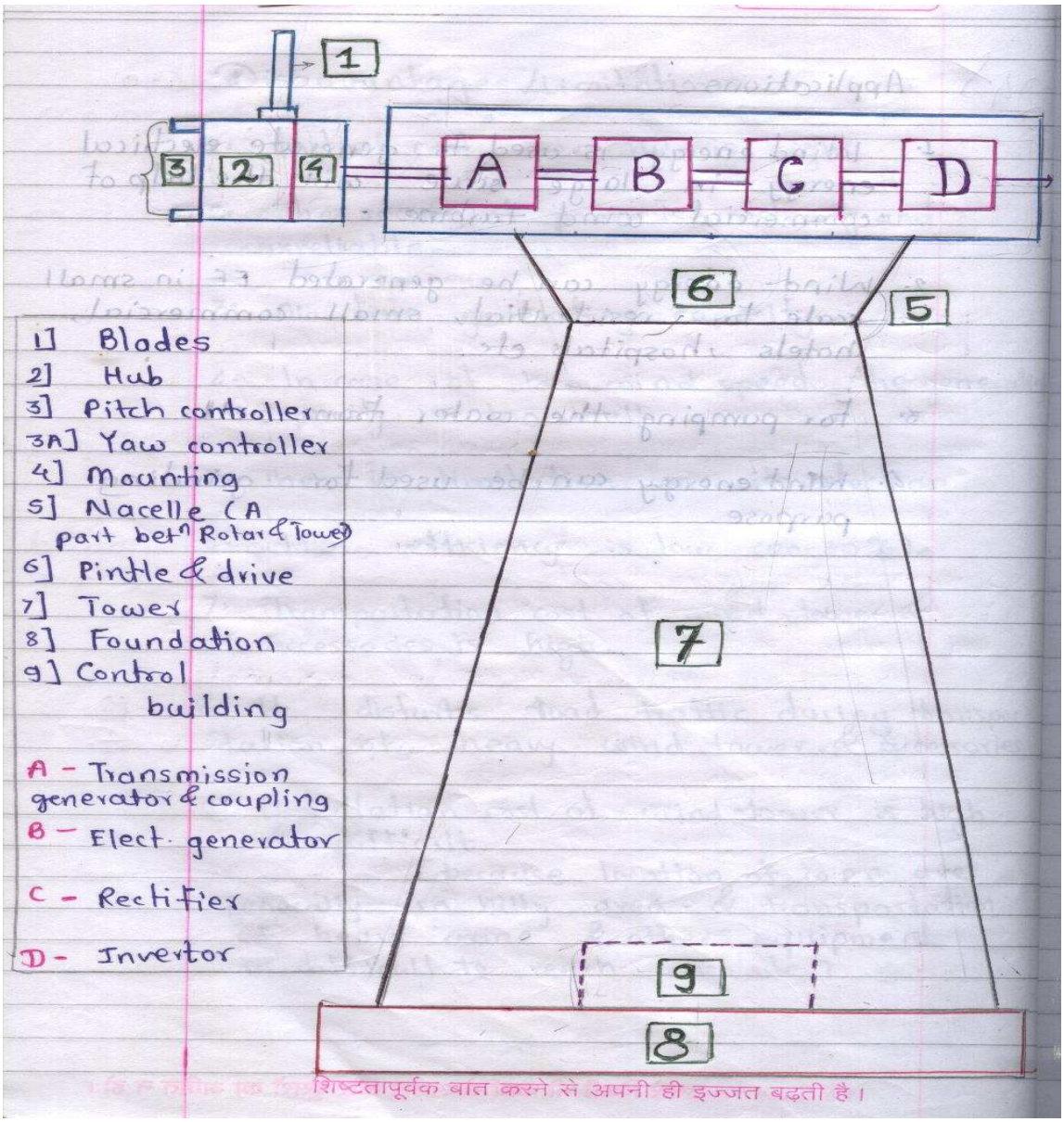
Typically wind turbines generate electricity through **asynchronous machines** that are directly connected with the electricity grid. The wind turbine generator is equipped with a double-fed three-phase induction generator. The advanced power electronics (IGBT converter) ensure that the generator works with high efficiency over the entire speed range. A heating winding is installed to prevent damage to the generator due to damp. In addition, there are sensors to monitor the temperature in the generator. The generator and the power electronics are cooled by a water-air heat exchanger. **OR**

In a turbine generator, magnets spin around a coil to produce current. The faster the magnets spin, the more current is induced in the coil. To make up for a direct drive generator's slower spinning rate, the diameter of the generator's **rotor** is increased hence containing more magnets which lets it create a lot of power when turning slowly. To reduce

the generator weight some constructors use **permanent magnets** (PM) in the generators' rotor, while conventional turbine generators use **electromagnets** fed with electricity from the generator itself. To enhance their competitiveness, the design of smaller generators with improved torque is still an active research area.

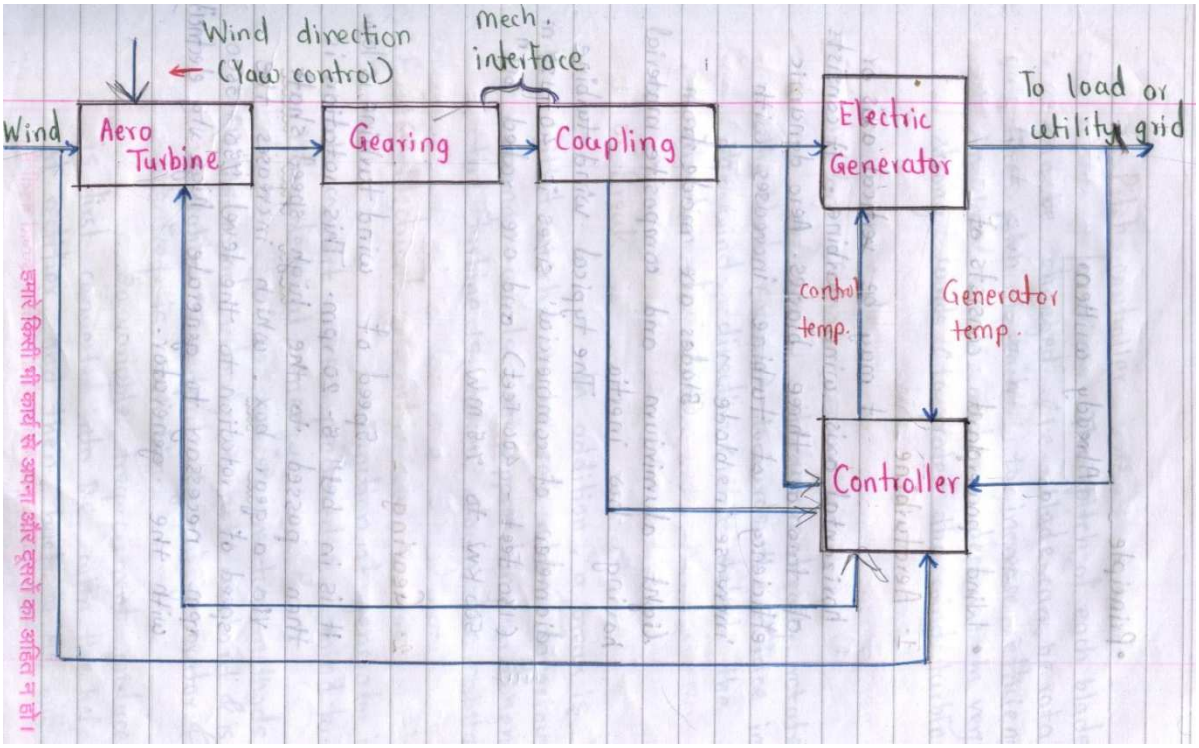
f) Draw the neat labelled diagram of wind mill and state its applications.

(Any one Diagram is expected-2 Marks & Application– 2 Mark)



OR

or equivalent figure OR



or equivalent figure

Application of Wind Mill: (Any Two Expected)

i) Wind energy is used to generate electrical energy in large scale with the help of commercial wind turbine.

ii) Wind energy can be generated electrical energy in small scale for residential, small commercial, hotels and hospitals etc.

iii) For pumping the water from well.

iv) Wind energy can be used for grinding purpose.

Q.5 Attempt any Four of the following **16 Marks**

a) What is the meaning of Bio-mass and Bio-gas energy? Give composition of Bio-gas and its calorific value. (Meaning-2 Marks & Composition of Bio-gas-1&Calorific Value–1 Mark)

Bio-mass and Bio-gas:-

The power plant in which biomass is used as a fuel to generate electrical is known as biomass power plant.

Composition of Bio-gas and its calorific Value:

In biogas plant, biogas also called as land fill gas (LFG) is produced. The composition of biogas is as below **(Note: Only Name of components is expected)**

S.No	Compound	Formula (Not expected)	% (Not expected)
1	Methane	CH_4	50-75 %
2	Carbon dioxide	CO_2	25-50 %
3	Nitrogen	N_2	0-10 %
4	Hydrogen	H_2	0-1 %
5	Hydrogen sulphide	H_2S	0-3 %
6	Oxygen	O_2	0 %

Out of which methane gas is useful to produce electricity by direct combustion or to run the gas engine in combination with generator. Calorific Value of Methane:

i) At 40% methane: 3124 Kcal / m^3

ii) At 50% methane: 4429 Kcal / m^3

iii)At 55% methane: 4713 Kcal / m^3

b) A generating Station has a connected load of 60 MW and maximum demand of 25 MW. The units generated being 60 x 10^6 KWh per annum. Calculate load factor and demand factor. **(Formula-1 Mark for each factor & Answer-1 Mark for each factor)**

$$Average\ Demand = \frac{Units\ generated\ /\ annum}{Hours\ in\ year}$$

$$= \frac{60\times10^6}{8760} = 6849.315\ kw$$

$$\textbf{Load Factor} = \frac{Average\ Demand}{Maximum\ demand}$$

$$= \frac{6849.315}{25\times10^3} = 0.273\ or\ 27.39\ \%$$

OR

$$Load\ \ factor = \frac{No.\ of\ units\ generated}{8760 \times Maximum\ demand}$$

$$= \frac{60\times10^6}{8760\times25\times10^3} = 0.273\ or\ 27.39\ \%$$

$$\textbf{Demand Factor} = \frac{Maximum\ demand}{connected\ load}$$

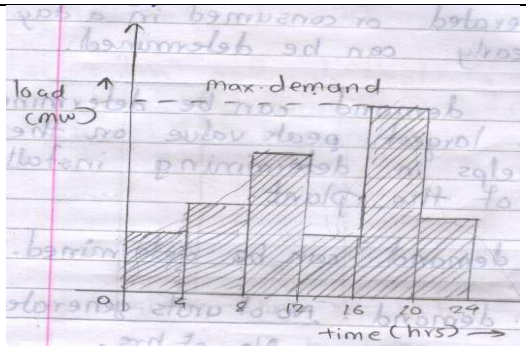
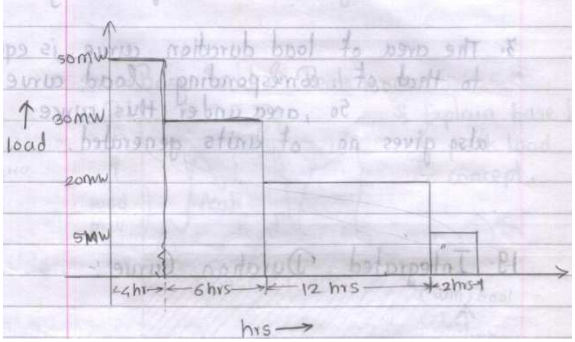
$$= \frac{25}{60}$$

Demand Factor = 0.4166

$$\textbf{Average Demand} = \frac{Units\ generated\ /\ annum}{Hours\ in\ year}$$

$$= \frac{60\times10^6}{8760} = 6849.315\ kw$$

c) Differentiate between load curve and load duration curve. (Any four point expected - 1 mark to each point)

S.No	Load Curve	Load Duration Curve
1	It is graphical representation of load (KW/MW) w.r.t time (hrs).	It is drawn from load curve. It is the graph of load (KW/MW) arranged in descending order of magnitude w.r.t time
2	Load at any time during a day are determine	How long a particular load exist
3	Load curve helps selection of most economical size (rating) & number of generating units (set of generator)	It helps to determine distribution of load between different generating set
4	Operation schedule of generating station can be determined	It helps to determine distribution of load between different generating set
5		

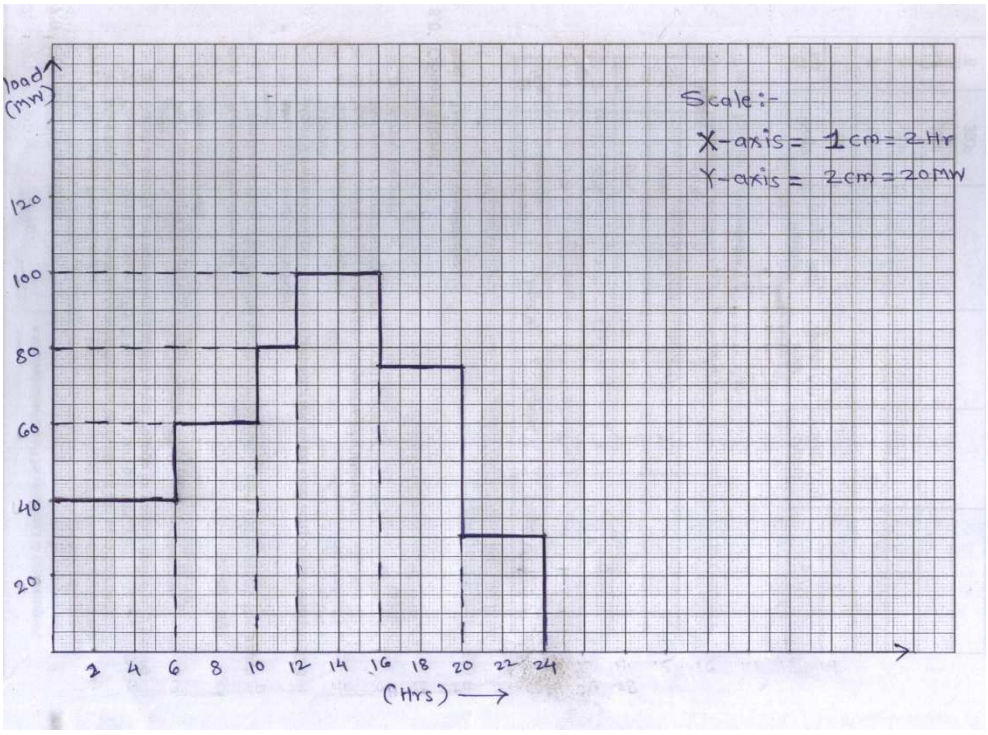
d) A generating station has following daily load cycle.

Time (Hours)	0-6	6-10	10-12	12-16	16-20	20-24
Load (MW)	40	60	80	100	75	30

i) Maximum Demand=? ii) Units generated per day=? iii) Average load+?

iv) Load Factor?

Solutions: **Graph:**



i) It is clear from the load curve that maximum demand on the power station is **100 MW** and occurs during the period 12-16

Maximum Demand: 100 MW ---------- **(1 Mark)**

ii) Units generated /day =

$$= Area\,(in\ KWh)\ under\ \ the\ load\ \ curve$$

$$= 10^3\ (40\times 6+60\times 4+80\times 2+100\times 4+75\times 4+30\times 4)$$

$$= 10^3\ (240+240+160+400+300+120)\ \ kWh$$

$$= 10^3\ (240+240+160+400+300+120)\ \ kWh$$

$$= 1460\times 10^3\ \ KWh$$ ---------- **(1 Mark)**

iii) Average Load =

$$= \frac{Units\ generated\ \ per\ day}{24\ hours} = \frac{1460 \times 10^3}{24} = 60833.33\ KW$$ ------- **(1 Mark)**

iv) Load Factor =

$$= \frac{Average\ \ load}{Maximum\ demand} = \frac{60833.33}{100 \times 10^3} = 0.60833$$

$$= 60.83\,\%$$ ---------- **(1 Mark)**

e) State the criteria by choice of size and number of generator units in a generating station. Explain briefly.

Following points should be considered while selecting size & number of generating units in generating station. (Any four point expected- 1 Mark each point)

i) The size & number of generating units should be so selected that they approximately match (fit) with annual load curve of generating station.

ii) Select the large number of generating units of different small capacity to match the load curve.

iii) The tendency to select a large number of units of smaller capacity in order to fit the load curve very accurately should be avoided.

iv) The installed capacity of the plant should be at least 15-20% more than maximum demand to meet the future load requirement.

v) There should be spare generating unit to increase the reliability.

f) What is meant by water hammer action in penstock of hydro-electric power station and method to reduce it? (Water Hammer effect-2 Mark & method of reduce -2 Mark)

Explanation:-

When load on power plant or alternator decreases then Governor (valve) reduces discharge of water. Due to sudden reduction in water discharge causes increase in pressure **of the**

water in the penstock. Due to high pressure penstock may damage. This effect is known as '**Water hammer effect'. OR**

When load on power plant or alternator decreases then

- Governor (valve) reduces discharge of water.
- Due to sudden reduction in water discharge causes increase in pressure in the penstock.
- Due to high pressure penstock may damage.
- This effect is known as 'Water hammer effect.

Effect is reduced: -

With the help of surge tank water hammer effect is eliminated **OR**

At that time surge tank helps by storing this rejected water immediately. In this way it avoids water hammer effect.

Q.6 Attempt any Four of the following **16 Marks**

a) State four advantages of interconnected power station.

(Any four Advantages Expected-1 Mark to each)

i) Reduced Overall installed Capacity:-

Inter connected power systems reduce the overall requirement of installed capacity. With interconnection between power systems, peak demand in an area is meet by importing power from neighboring area. Thus, it also reduces investment and fulfills the peak demand.

ii) Better Utilization Hydro Power:-

In combined power system, hydro power can be utilized in more effective way. during rainy season, hydro power plant can be utilized, while during draught periods, steam power plant can be used as base load plant.

iii) Reliability of Supply:-

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

iv) High unit size possible:-

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

v) Improved quality of voltage and frequency:-

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

vi) Exchange of peak loads:-

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

vii) Use of older Plants:-

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

viii) Insure Economical operation:-

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

ix) Increases Diversity factor:-

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

x) Increases load factor:-

The load factor and efficiency of operation are improved.

xi) Reduces Plant Reserve capacity:-

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

xii) Better utilization of natural resources:

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

b) Compare thermal, Hydro, Nuclear and diesel Power plants on the basis of i) Running cost ii) Use as base load or peak load . (4 Mark)

S.No	Basis of point	Thermal P.P	Hydro P.P	Nuclear P.P	Diesel P.P
1	**Running Cost**	High	Lowest	Higher than T.P.P	Highest
2	**Use as base load or peak load**	Base load	Peak load also Large storage H.P.P may be used as a base load power plant	Base load	Peak load

c) What is meant by economic loading of interconnected power stations? How the economic loading is achieved? (Economic loading -2 Mark & How it is achieved-2 Mark)

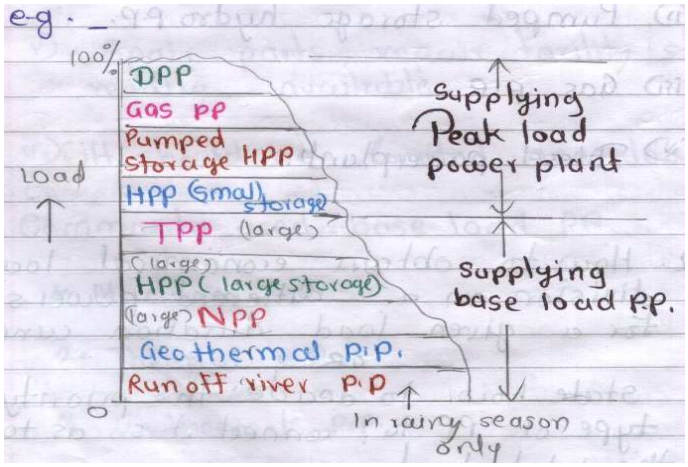
Note: - In this questions credit may be given by judgment on part of examiner of relevant answer based on candidate understanding.

Economic Loading means:

The power plant whose generating cost per unit is less will share maximum load during whole day. And the power plant whose generating cost per unit is more will share minimum load for few hours during a day (peak load) is called economic loading of interconnected power system.

Economic loading is achieved as shown in figure:

Following figure indicates priority of type of plant share the load.



or equivalent figure

d) Differentiate between state grid and national grid. What precautions must be taken in case of national grid? (Any two Difference point -2 Mark each point & Precautions -2 Mark)

Note: - In this questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.

S.No.	State Grid	National Grid
1	All major generating stations in state are interconnected to each other through transmission line is called as state grid.	All state grids are interconnected to each other through transmission line is called 'National grid.
2	Control of authority is state level load dispatch centre	Control of authority is National level load dispatch centre

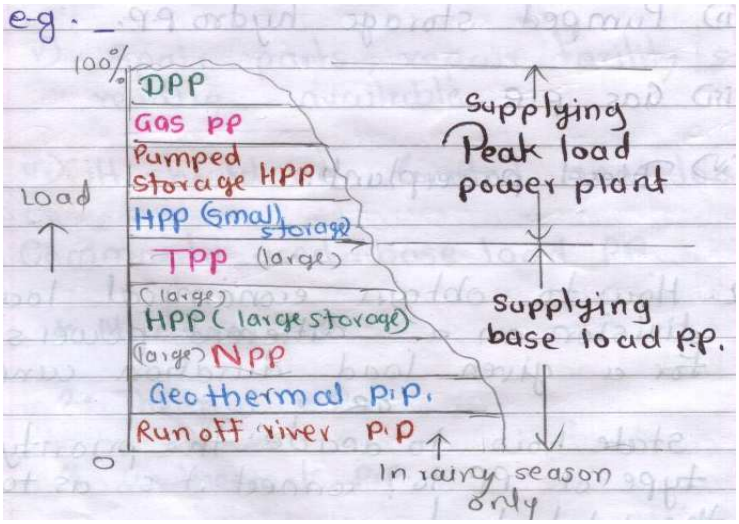
Precautions must be taken in case of national Grid:

Precaution should be taken that load on grid is adjusted in such way that, avoid cascade tripping during peak load period.

e) Explain how to decide the priority of types of plant to share the load.

Note: - In this questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands. (4Marks)

Following figure indicates priority of type of plant share the load.



or equivalent figure

f) Define the following terms related to Economics of power generation connected load, spinning reserve, plant capacity factor and plant use factor.

(Each Definition -1 Mark each)

1. Connected Load :

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

The sum of continuous rating of all the equipments in consumer premises is the connected load of consumer and the sum of connected load of all the consumers is the connected to the power station or power system.

2. Spinning Reserve :

It is the generating capacity to bus bar & ready to take a load.

3. Plant Capacity Factor:

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

$$Plant\ \ Capacity\ \ Factor = \frac{Actual\ \ energy\ (KWH)\ produced}{Maximum\ possible\ energy\ that\ \ could\ have\ \ been\ produced}$$ **OR**

$$Plant\ \ Capacity\ \ Factor = \frac{Average\ Demand}{Installed\ (Rated)\ capacity\ of\ \ plant}$$ **OR**

$$Plant\ \ Capacity\ \ Factor = \frac{Total\ KWH\ \ generated\ during\ a\ given\ period}{Number\ of\ \ hrs\ in\ that\ \ period \times Installed\ rated\ capacity\ of\ \ plant}\ OR$$

$$Plant\ \ Capacity\ \ Factor = \frac{Avrage\ demand}{Maximum\ demand} \times \frac{Maximum\ demand}{Installed\ rated\ capacity\ of\ \ plant}$$

$$\therefore Plant\ \ Capacity\ \ Factor = Load\ \ factor \times Utilization\ \ factor$$

4. Plant Use factor:

It is the ratio of number of units (KWH) generated to the product of installed capacity of plant & the number of hours for which the plant was in operation.

$$Plant\ \ Use\ \ Factor = \frac{Number\ of\ \ units\ (KWH)\ generated\ (Station\ o/\ p\ in\ KWH)}{Installed\ capacity\ of\ \ plant \times Number\ of\ \ hours\ \ plant\ in\ operation}$$

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