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Roll no → 235012
Subject → BEE
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A1

Assignment.

Ques-1. Derive the relation b/w line current and the phase current also the line voltage and phase voltage in the delta type of connection.

Sol^n Relation b/w line current and phase current in delta.

Since the system is balanced the three phase currents I_{RY}, I_{YB} and I_{BR} are equal in magnitude but differ in phase from one another by 120°.

Let $I_{RY} = I_{YB} = I_{BR} = I_{PH}$

where I_{PH} indicates rms value of the phase current.

$$I_{RY} = I_{PH} \angle 0°$$

$$I_{YB} = I_{PH} \angle -120°$$

$$I_{BR} = I_{PH} \angle -240°$$

$$I_R = I_Y = I_B = I_L$$

where I_L indicates rms value of line current.

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Applying KCL,

$$I_R + I_{BR} = I_{RY}$$

$$I_R = I_{RY} - I_{BR}$$

$$= I_{PH} \angle 0^\circ - I_{PH} \angle -240^\circ$$

$$= (I_{PH} + j0) - (0.5 I_{PH} + j0.866 I_{PH})$$

$$= 1.51 I_{PH} - j\,0.866 I_{PH}$$

$$= \sqrt{3}\, I_{PH} \angle -30^\circ$$

Similarly,

$$I_Y = I_{YB} - I_{RY} = \sqrt{3}\, I_{PH} \angle -30^\circ$$

$$I_B = I_{BR} - I_{YB} = \sqrt{3}\, I_{PH} \angle -30^\circ$$

Thus in a delta connected, three phase system, $I_L = \sqrt{3} I_{PH}$ and line currents lag behinds the respective phase currents by 30°

=> Relation b/w line voltage and phase voltage

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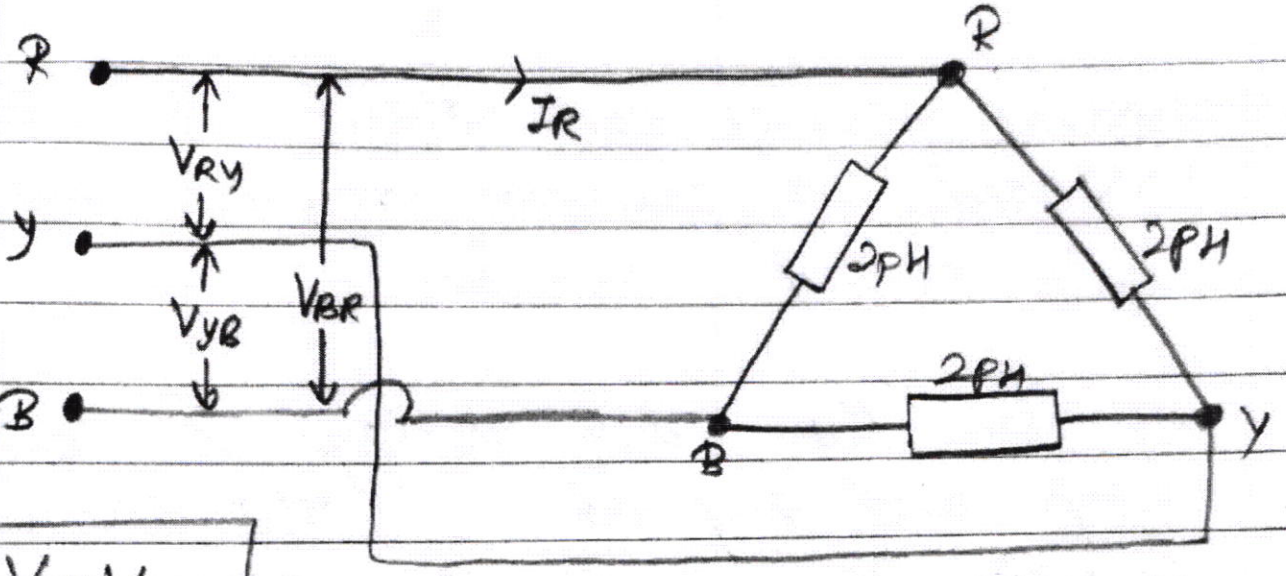
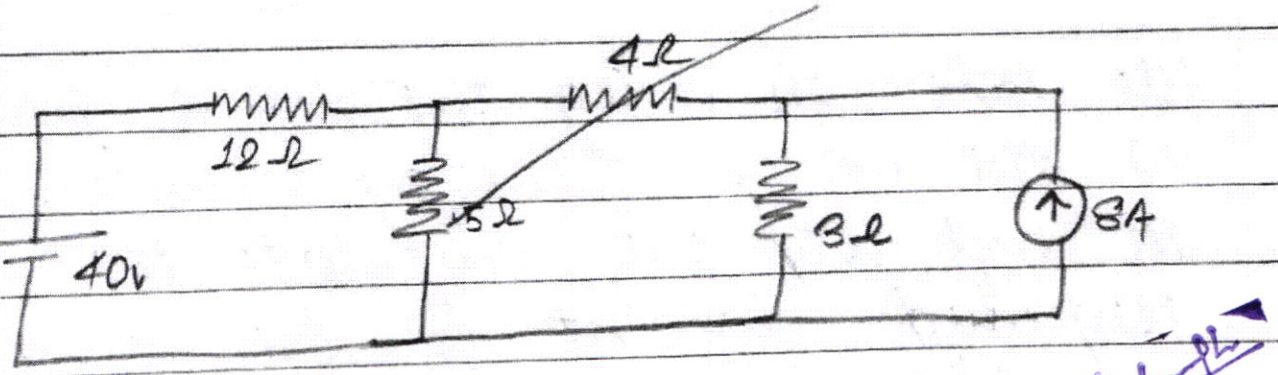


$V_L = V_{PH}$

With an example explain and demonstrate the superposition theorem.



This theorem is applied for a circuit having multiple voltage and current sources. In this theorem we take only one voltage source or current sources at a time. All other.

voltage source and short circuit and all current sources are open circuit.

We take the other voltage in text step and repeat the same process. If firstly we take 40V as active, then in next round we will take 8A current sources as active.

We take on doing the same process as the no. of energy sources. In each step we calculate the required current in the branch which is asked.

We sum all the current calculated in each step to find the final current value of the branch.

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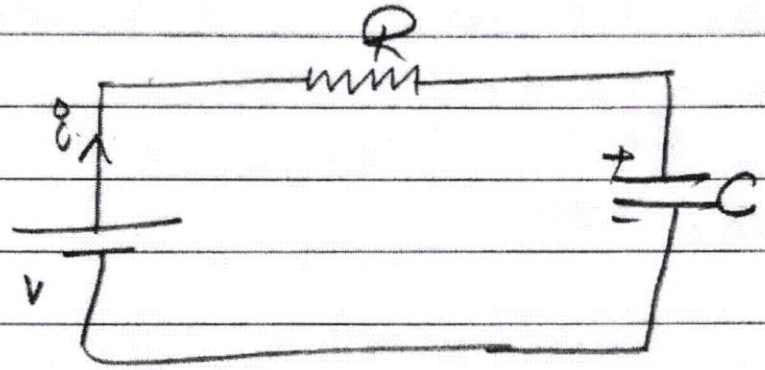
Ques-3 Derive the expression of current in transient response of R-C and R-L circuit.

Soln # R-C circuit



$$V_C = \frac{q}{C} = \frac{\int i\,dt}{C}$$

Applying KVL,

$$= -V + i(t)R + K_C = 0$$

$$= -V + i(t)R + \frac{\int i\,dt}{C} = 0$$

differentiating both side

$$\Rightarrow \frac{R\,di(t)}{dt} + \frac{i\,d(t)}{C} = 0$$

alternating current is applied for same time.

Average value :→ It can be defined as the arithmetic mean of all the values over one complete cycle.

- Peak value → It can be defined as the mean of all values to rms value of given quantity.

- Form Factor → It is defined as ratio of rms value of average value of given quantity.

INDEX

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Subject BEE (Assignment) Roll No. 231053

S. No.	Date	Title	Pg. No.	Teacher's Sign/ Remarks

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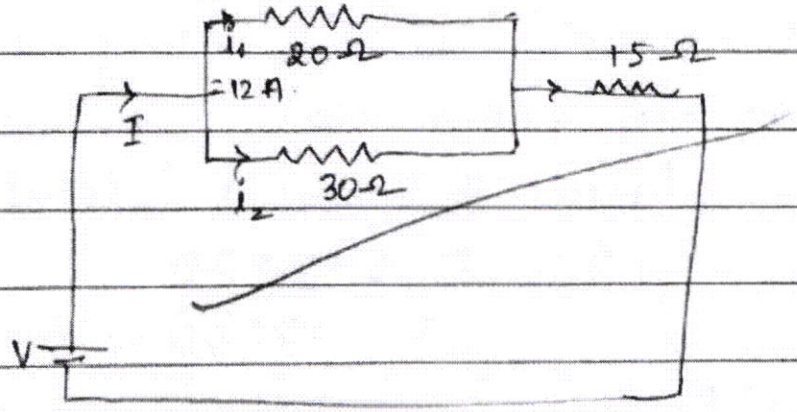
ASSIGNMENT-01

A current consist of two parallel resistance having resistances of 20 Ω and 30 Ω connected in series with a 15 Ω resistor. If the current in 30 Ω resistor is 1.2 A. Find:-

- currents in 20 Ω and 15 Ω resistor.
- voltage across whole circuit.
- Total power consumed in the circuit.

First, we will draw the circuit diagram of given data



We have, $i_2 = 12\ A$

As we know that, $12 = I \left(\frac{30}{30+20}\right)$

$$\frac{12 \times 50}{30} = I$$

$$\therefore \boxed{I = 20\ A}$$

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∴ current in 20 Ω resistor

$$\Rightarrow i_1 = I \times \left(\frac{20}{20+30}\right)$$

$$\Rightarrow \boxed{i_1 = 8\,A}$$

∴ current in 15 Ω resistor $\Rightarrow I = 20\,A.$

② As we know that,

$$V_{total} = I_{total} \times R_{total}$$

$$= 20\left(\frac{60}{3+2} + 15\,\Omega\right)$$

$$= 20 \times 27$$

$$\therefore \boxed{V_{total} = 540\ V.}$$

③ Again, as we know that,

$$P_{total} = V_{total} \times I_{total}$$

$$= 540 \times 20$$

$$= 10800\ watt.$$

∴ Total Power consumed

= 10800 watts.

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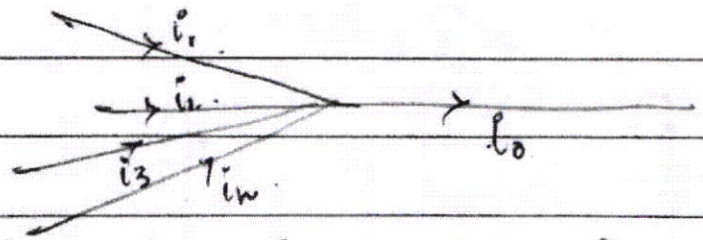
Explain kirchoff's law using suitable example.

Kirchoff's law applied for both current and voltage, so there is two types of kirchoff's law.

① Kirchoff's current law KCL.

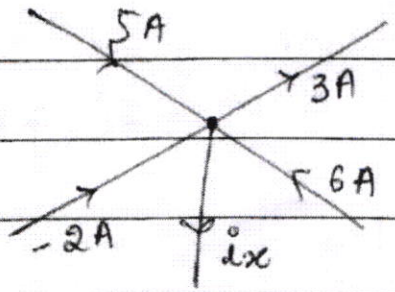
KCL states that in a closed circuit, the "summation" of incoming must be equal to "summation of outgoing current".

In other words, the algebraic sum of currents entering at a node is equal to zero.



$$i_o = i_1 + i_2 + i_3 + \dots i_n$$

Ex. ①



By using KCL we get

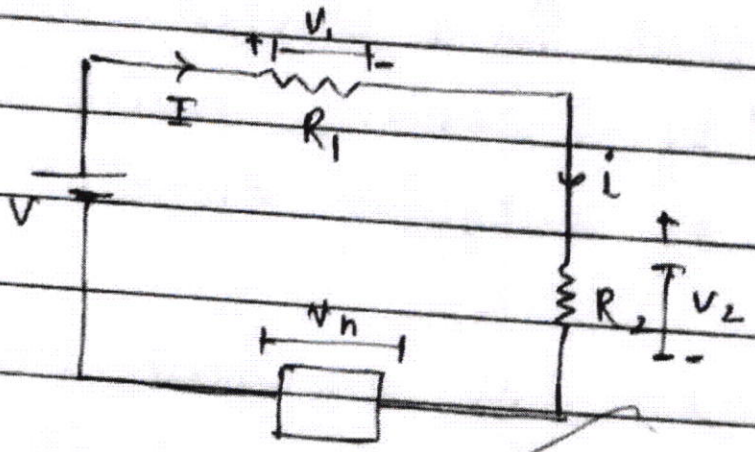
$$5 + (-2) + (6) = 3 + i_x$$

$$11 - 2 = 3 + i_x$$

$$\boxed{i_x = 6A}$$

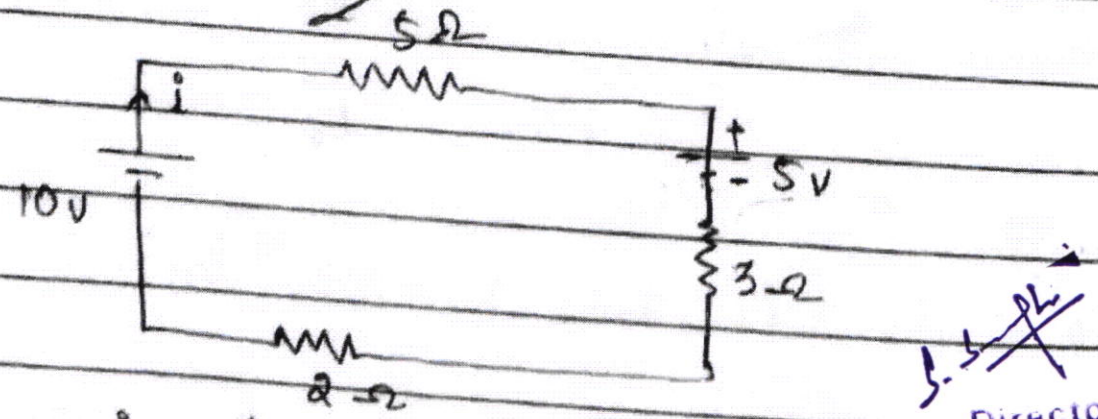
Kirchoff's Voltage law (KVL)

KVL states that, in a closed path, the algebric sum of all the voltage drop across each elements (resistors, capacitors, inductors) and the voltage sources must be zero.



$$-V + IR_1 + IR_2 + \cdots V_n = 0$$

1.



By using KVL, we get

$$-10 + 5i + 5 + 3i + 2i = 0$$

$$10i - 5 = 0$$

$$10i = 5$$

$$i = \frac{5}{10}$$

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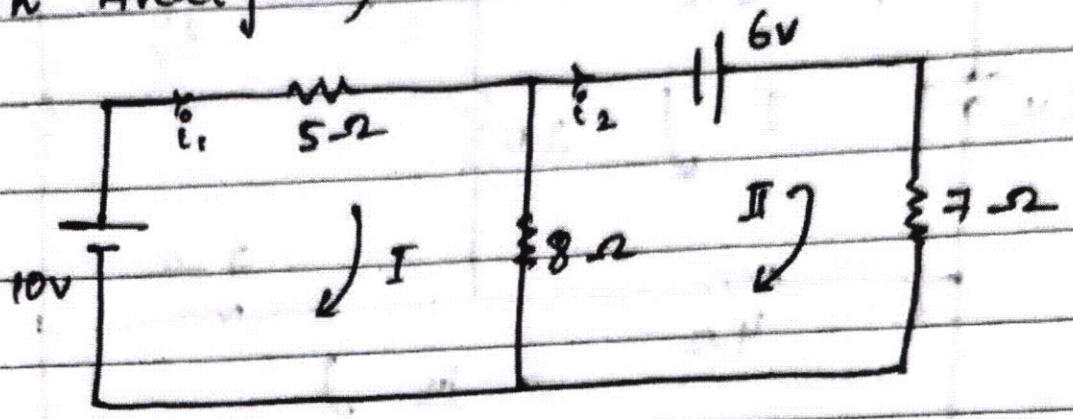
Q 3. (Mesh Analysis)



Find i_1 and i_2 :-

Sol^n → By using KVL at Mesh (I), we get

$$-10 + 5i_1 + 8(i_1 - i_2) = 0$$

$$13i_1 - 8i_2 = 10 \quad \text{——— (1)}$$

By using KVL at Mesh (II), we get

$$-6 + 7i_2 + 8(i_2 - i_1) = 0$$

$$-8i_1 + 15i_2 = 6 \quad \text{——— (2)}$$

By using solving eq. (1) and (2).

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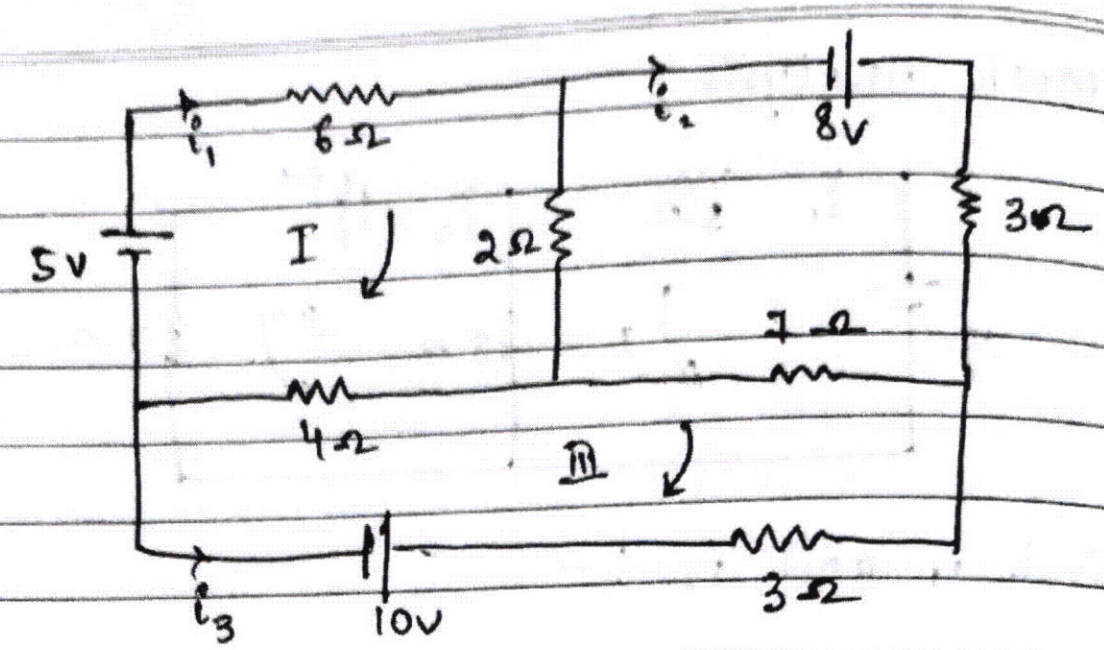
$\therefore$ $\boxed{i_1 = 1.511 \text{ A}}$ and $\boxed{i_2 = 1.106 \text{ A}}$

Q4:



Sol: In the given circuits :-

There are three Meshes.

By using KVL at Mesh (I), we get

$$-5 + 6i_1 + 2(i_1 - i_2) + 4(i_1 - i_2) = 0$$

$$\Rightarrow 11i_1 - 2i_2 - 4i_3 - 5 = 0$$

$$\Rightarrow 12i_1 - 2i_2 - 4i_3 = 5 \quad \longleftarrow (1)$$

Again, By using KVL at Mesh (II), we ge

$$-8 + 3i_2 + 7(i_2 - i_3) - 2(i_2 - i_1) = 0$$

$$\Rightarrow -2i_1 + 12i_2 - 7i_3 = 8 \longleftarrow$$

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Again, By using KVL at [illegible] get

$$-10 + 3i_3 + 7(i_3 - i_2) + 4(i_3 - i_2) =$$

$$\Rightarrow -4i_1 - 7i_2 + 14i_3 = 10$$

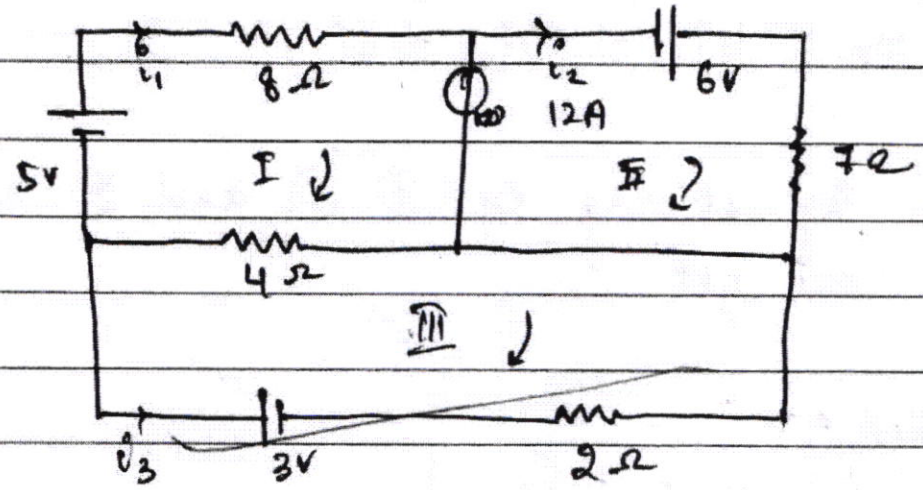
By using solving eq. ①, ② and ③

$\therefore \boxed{i_1 = 1.557\ A}$

$\therefore \boxed{i_2 = 2.262\ A}$

$\therefore \boxed{i_3 = 2.290\ A}$

Q5.



Find the Power delivered to 4Ω resistor.

Sol: In the given circuit,

KVL for supermesh I and II, we get

$-5 + 8i_1 - 6 + 7i_2 + 4(i_1 - i_3) = 0$

$\Rightarrow 8i_1 + 4i_1 + 7i_2 - 4i_3 - 11 = 0$

$\Rightarrow 12i_1 + 7i_2 - 4i_3 = 11$

From mesh I and II, common current, we get,

$$i_1 - i_2 = 12 \quad \text{——— (2)}.$$

KVL for Mesh III, we get.

$$3 + 2i_3 + 4(i_3 - i_1) = 0$$
$$\Rightarrow -4i_1 + 0i_2 + 6i_3 = -3 \quad \text{——— (3)}$$

$\therefore$ By solving eq. (1), (2) and (3) eqn., we get

Hence,

$$\boxed{i_1 = 5.693\ A},$$

$$\boxed{i_2 = -6.306\ A}$$ And

$$\boxed{i_3 = 3.295\ A}$$

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Netaji Subhas Institute of Technology, Bihta, Patna

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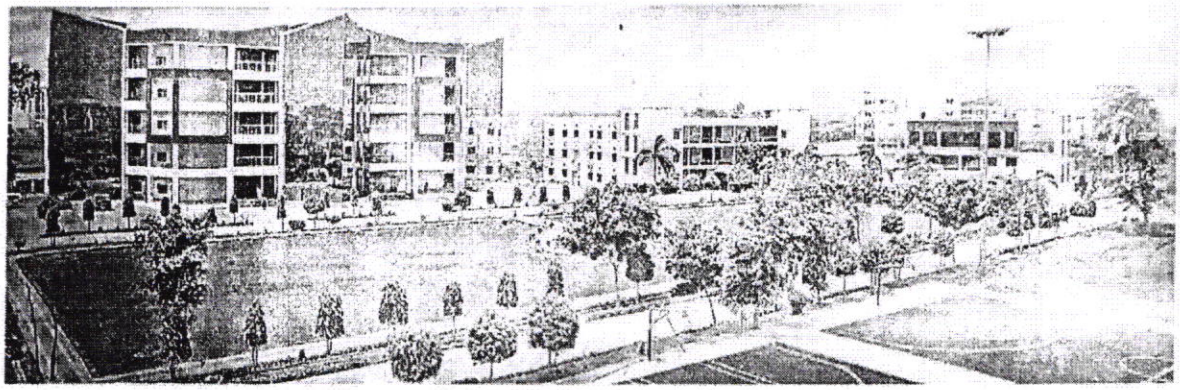
ASSIGNMENT-1

Power Plant Engineering

Subject code- 110807



DEPARMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

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SEMESTER-VIIIth

BATCH- 2020 – 2024

SESSION- 2023 - 2024

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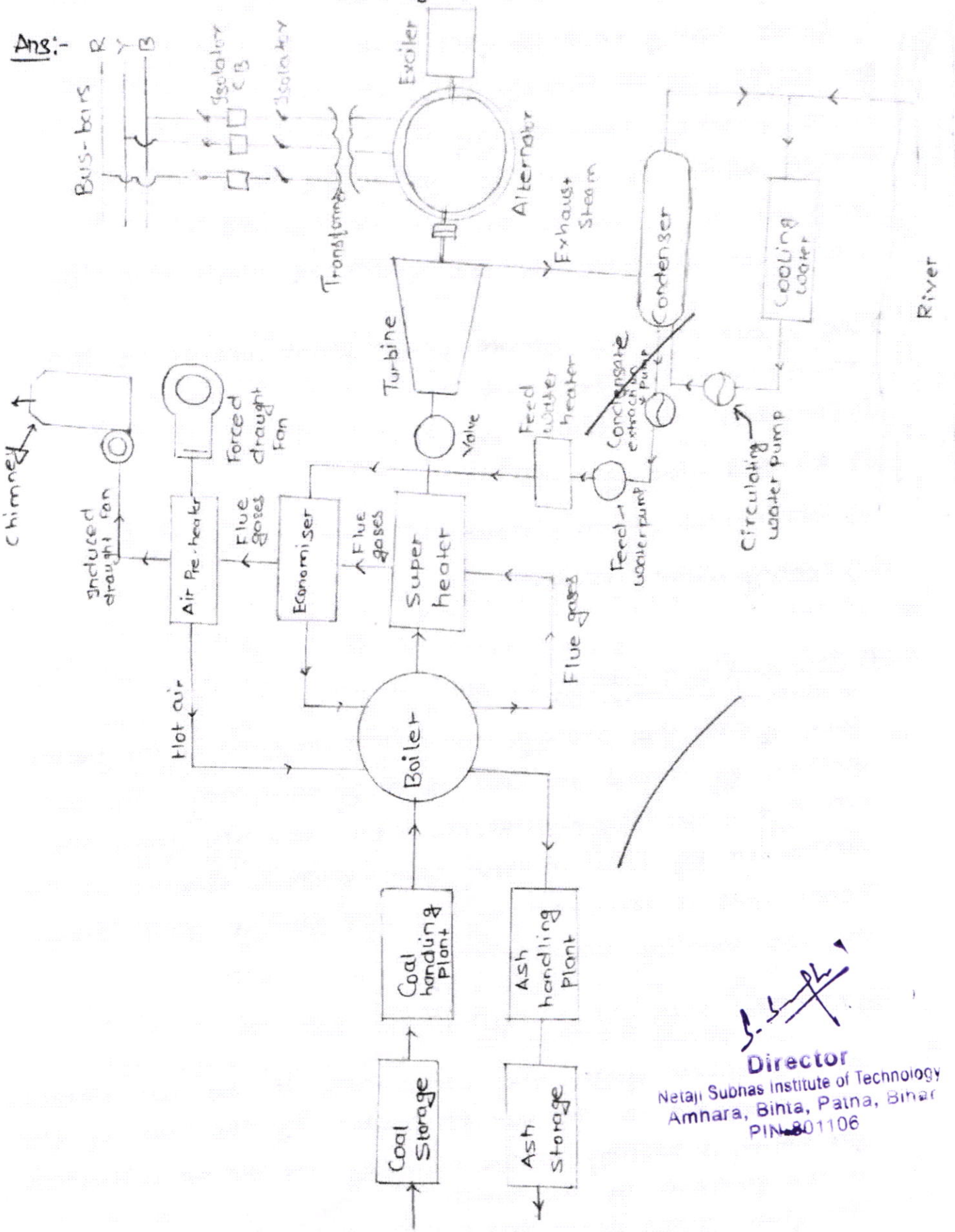
Q1) Explain With a simple sketch Working of thermal Power Plant With all the four Circuits involved in it.

Ans:-



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A steam power plant, also known as thermal power plant, is using steam as working fluid. Steam is produced in boiler using coal as fuel and is used to drive the prime mover, namely, the steam turbine. In the steam turbine, heat energy is converted into mechanical energy which is used for generating electric power. Generator is an electro-magnetic device which makes the power available in the form of electrical energy.

> The layout of the steam power plant consists of four main circuits. These are :-

(i) Coal and ash circuit
(ii) Air and flue gas circuit
(iii) Water and steam circuit and
(iv) Cooling water circuit.

(i) Coal and ash circuit :-

Coal from the storage yard is transferred to the boiler furnace by means of coal handling equipment like belt conveyor, bucket elevator, etc. ash resulting from the combustion of coal in the boiler furnace collects at the boiler and is removed to the ash storage yard through the ash handling equipment.

(ii) Air and Flue gas Circuit :-

Air is taken from the atmosphere to the air preheater. Air is heated in the air preheater by the heat of flue gas which is passing to the chimney. The hot air is supplied to the furnace of the boiler.
The flue gases after combustion in the furnace, pass around the boiler tubes.

(iii) Feed water and flow circuit :-

The steam generated in the boiler passes through super heater and is supplied to the steam turbine and the work pressure of steam is reduced. The expanded steam then passes to the condenser, where it is condensed.

The condensate leaving the condenser is first heated in a 1 h.p water heater by using the steam taken from the low low pressure extraction point of the turbine. Again steam taken from the high pressure extraction point of turbine is used for heating the feed water in H.P water heater.

(iv) Cooling water circuit :-

Abundant quantity of water is required for condensing the steam in the condenser. water circulating through the condenser may be taken from various sources such as river or lake, provided adequate water supply is available from the river or lake, provided adequate water supply is available from the river or lake throughout the year.

If adequate quantity of water is not available at the plant site, the hot water from the condenser is cooled in the tower or cooling ponds and circulated again.

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Q2) Describe the in plant coal handling with a neat diagram. [5]

Ans:- Coal delivery equipment is one of the major components of plant cost. The various steps involved in coal handling are as follows.

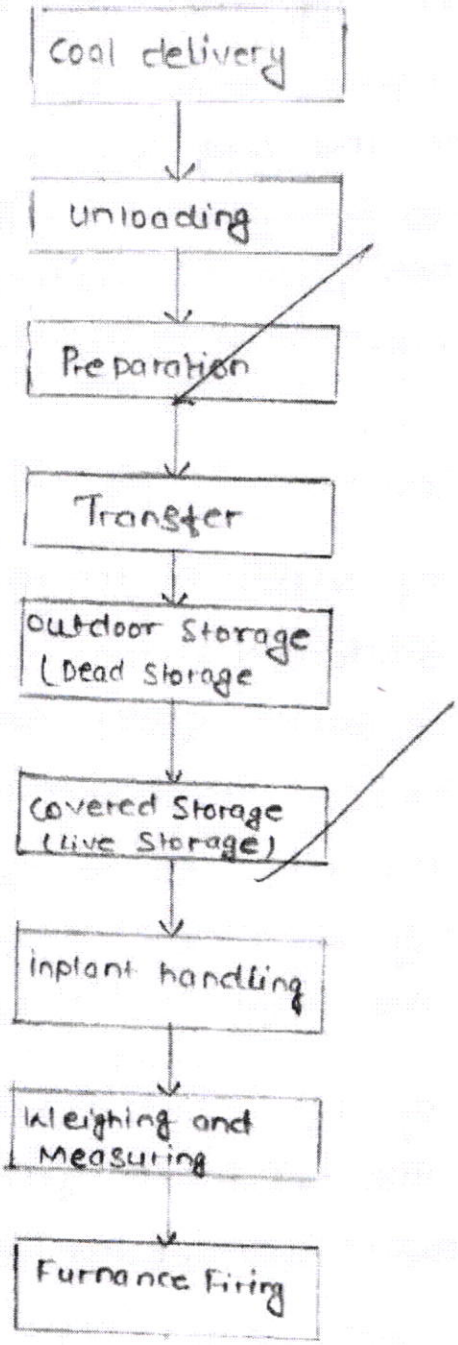

Fig:- Steps involved in coal handling system

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(i) Coal delivery :-

The coal from supply points is delivered by ships or boats to power stations situated near to sea or river whereas coal is supplied by rail or trucks to the power stations which are situated away from sea or river. The transportation of coal by truck is used if the railway facilities are not available.

(ii) Unloading :-

The type of equipment to be used for unloading the coal delivered by trucks, there is no need of unloading device as the trucks may dump the coal to the outdoor storage. Coal is easly handled if the lift trucks with scoop are used.

(iii) Preparation :-

When the coal delivered is in the form of big lumps and it is not of proper size, the preparation (sizing) of coal can be achieved by crushers, breakers, sizers, driers and magnetic separators.

(iv) Transfer :-

After preparation coal is transferred to the dead storage by means of the following systems.

1) Belt conveyors
2) Screw conveyors
3) Bucket elevators
4) Grab bucket elevators
5) Skip hoists
6) Flight conveyor

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v) Coal storage :-

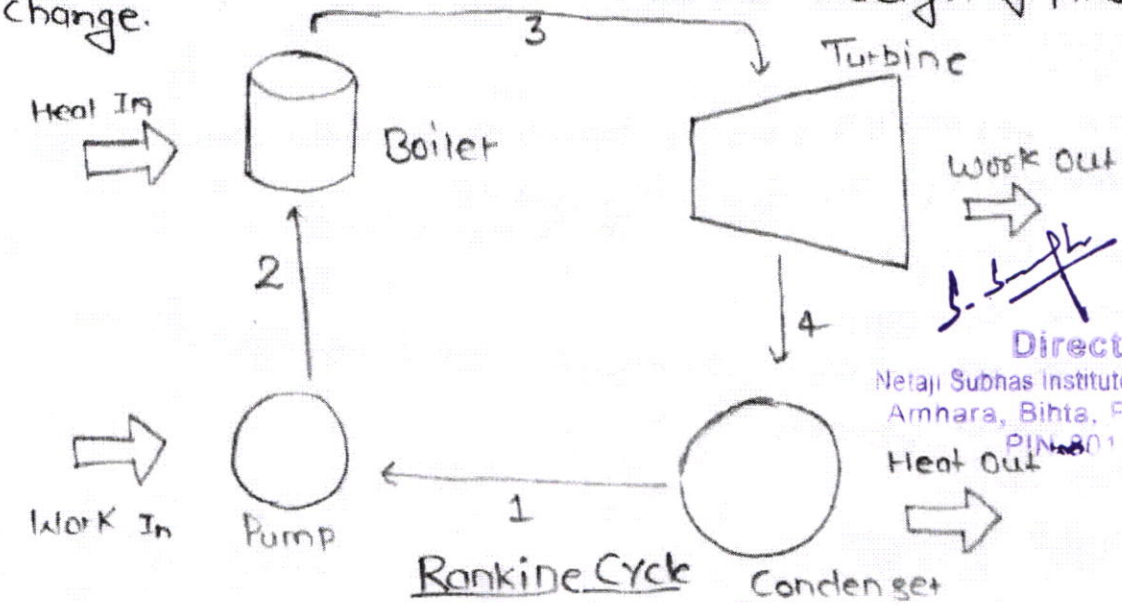
The key purpose of Coal storage is to provide reserves for power plants. Storage for Coal is important for many reasons to ensure smooth operation of power Plants

vi) Ash Handling :-

Ash handling system are mechanical device that correctly dispose of the ash so, after the coal has been burned, the ash fro the Coal is collected and disposing of it, it must be cooled down to a manageable temp. It is then transfered to a disposal or storage area and used in various industries.

Q3) Explain Rankine cycle and its components.

Ans- The Rankine cycle is a model used to predict the Performation of steam turbine systems. It was also used to study the performance of reciprocating steam engines. The Rankine cycle is an idealized thermodynamic cycle of a heat engine that converts heat into mechanical work while undergoing phase change.



> Components of the Rankine Cycle :-

1) Pump :-

They can be centrifugal pumps in industrial applications. water as saturated liquid enters the pumps and is compressed.

2) Boiler :-

Boilers are generally heat exchangers as in thermal Power Plants. The compressed liquid enters the boiler to be converted to super heated steam.

3) Turbines :-

Turbines or steam turbines are machines that use Pressurised steam to produce mechanical work. The superheated steam entering the turbine expands and rotates the shaft to produce work which generates electricity.

4) Condenser :-

Condenser has a set of tubes with a cooling medium surrounding it. The cooling medium may be air or water depending upon the placement of the power Plant. steam, in a saturated liquid-vapor state, is condensed at constant pressur and the heat is rejected to a cooling medium.

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Q4) Explain the methods used to increase thermal efficiency of a steam power plant.

Ans:- Methods of improving the efficiency of therm power Plants:-

i) Increasing initial steam parameters:-

The temperature difference between the heat and cold sources determines the limit of the efficiency of a heat engine. the efficiency of thermal power plants could be improved by increasing the initial steam Parameters.

High-Volume-high-parameters supercritical (SC) and ultra-Supercritical (USC) thermal power plants have Proven stable and effective for large-scale Commercial power generation. Supercritical power plants (25 MPa, 566°c/566°c) can attain an efficiency 2% to 3% higher than sub-critical power plants while ultra supercritical (30MPa, 600°c/600°) thermal power plants boast an efficiency even 2%-3% higher.

ii) Lowering final steam parameters:-

Given a fixed set of initial steam parameters, lowering the final steam parameters will allow for a greater temperature difference between T_{steam} and $T_{condenser}$, thus hitting the theoretical efficiency threshold for thermal power plant.

In thermal power plant, condenser is the place where the waste steam is condensed, after which the water will be pumped back in to the boiler.

Most modern thermal power plants use either water-cooled Condenser or air-cooled Condenser as the cold source in the cycle. water cooled Condensers could be classified into cooling systems with open or close cycle. Air Cooled Condenseres could be classified into direct or indirect cooling systems

3) Water pre-heater:-

In the water pre-heater, the expanded steam is extracted from the turbine under certain parameters, which is then used to heat the water before Pumping it into the turbine. In such a system, energy from extracted steam is transferred back into the system, where the cold source loss would be much smaller than a simple Rankine cycle. Further more, the extraction consists of several stages.

The longer the extraction from the turbine takes, the lower temperature of water for heating. In this way, steam could do more work on the turbine before getting extracted, thus increasing the thermal efficiency of the turbine. Each turbine has a distinct set of optimum steam extraction parameters.

Q5) Explain why the super heater tubes are flooded with water at the starting of the boilers?

Ans: In a boiler system, superheater tubes are flooded with water at the start to ensure the initial stages of heating proceed smoothly and safely. Here 'why this is done:-

1) Preventing Thermal Stage:-

Superheater tubes are exposed to extremely high temperatures during operation, If they were initially exposed to these temperatures without water, rapid heating could cause thermal stress and potential damage to the metal, By flooding them with water initially, the tubes are protected from thirmal block.

2) Even Heating:-

Water acts as a buffer, allowing for a more gradual increase in temperature. this gradual heating prevents sudden expansion or contraction of the tubes, which could otherwise lead to mechanical stress and deformation.

3) Boiler Safety:-

Ensuring the superheater tubes are filled with water initially is a safety measure, it prevents overheating of the metal, which could weaken it over time and potentially lead to failures or leaks.

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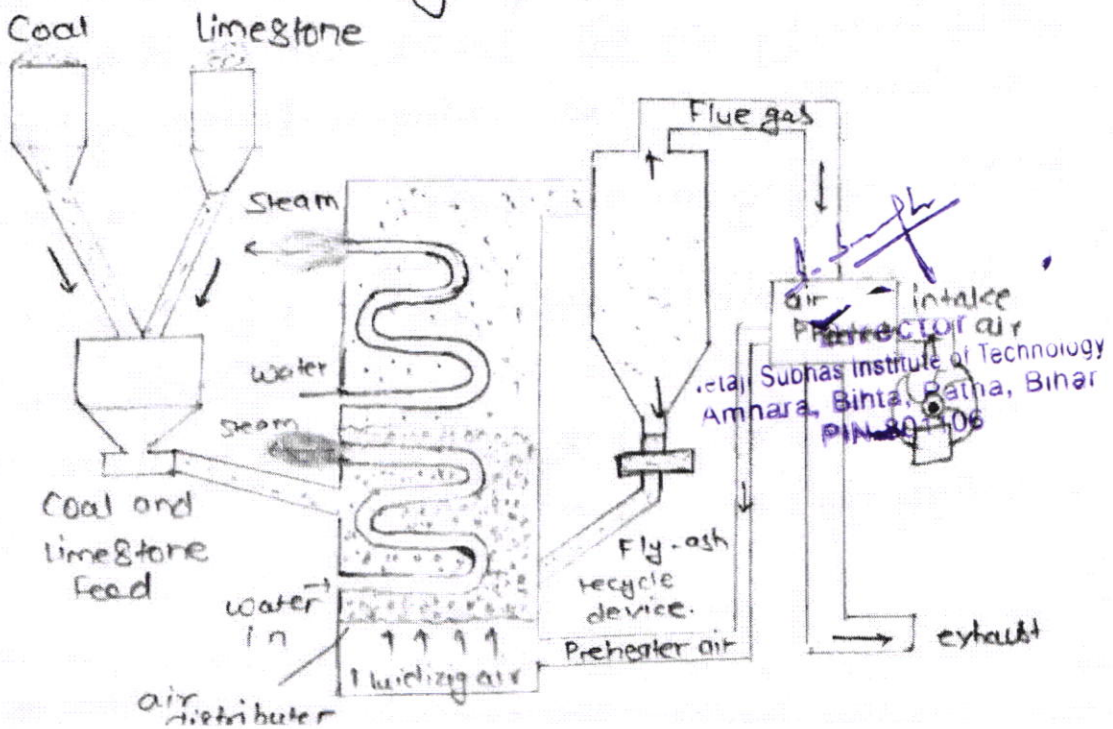
4) Operational stability:-

By starting with water in the superheater tubes, the boiler can ramp up more smoothly and efficiently to its operational temperature. This process helps maintain stable and predictable conditions within the boiler system.

Q6) What is Fluidised Bed combution system? Sketch and describe a Fluidised Bed combution (FBC) system. State the advantages of FBC system

Ans: Fludised bed combution (FBC) is a combution technology used to burn solid fuels. A bed of solid Particles is said to be fludised when the pressurized fluid (liquid or gas) is passed through the Medium and causes the solid particles to behave like a fluid under certain conditions. Fludization causes the transformation of the state of solid Particales from static to dynamic.



A fluidized bed boiler is an intriguing combustion system that suspends solid particles in an upward flow of gas or air. The process of "fluidized" characterizes the behaviour of solid particles, which resemble the characteristics of a fluid due to the upward velocity induced by the gas stream. This results in a highly efficient combustion process, facilitating a superior combination of fuel and air.

> Advantages of Fluidized Bed Combustion Boilers:-

i) High Combustion Efficiency:-

FBC boilers can with a combustion efficiency of over 95%. irrespect of ash content. FBC boilers can operate with overall efficiency of 84% (plus or minus 2%)

ii) Reduction in boiler size:-

High heat transfer rate over a small heat transfer area immersed in the bed result in overall size reduction of the boiler

iii) Ability to Burn Fines:-

Coal containing fine below 6 mm can be burnt efficiently in FBC boiler. which is a very difficult to achieve in conventional firing system

iv) No slagging in the Furnance - No soot Blowing:-

In FBC boilers, volatilisation of alkali components in ash does not take place and the ash is non sticky. This means that there is no slagging or soot blowing.

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7) Explain the principle of fire tube and water tube boilers.

Ans:- The Working Principle of the fire tube boiler :-

In a fire tube boiler, hot gases pass through a series of tubes that are immersed in water within the boiler shell. The heat from the gases is transferred through the walls of tubes to the water, creating steam.

Here are the key steps in the working principle :-

1) Fuel combustion :-

The boiler is fueled, typically with coal, wood, or oil. The fuel undergoes combustion in the furnace, generating hot gases.

2) Gases Flow through Tubes :-

The hot gases produced during combustion travel through the tubes that are submerged in water.

3) Heat Transfer :-

As the hot gases move through the tubes, heat is transfered from the gases to the water surrounding the tubes. This heat transfer raises the temperature of the water and converts it into steam.

4) Steam generation :-

The steam produced is collected in the upper part of the boiler, ready for use in various applications such as power generation or heating.

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5) Exhaust :-

After transferring heat to the water, the cooled gases exit the boiler through the chimney or stack.

> Water Tube Boiler Working Principle :-

i) Fuel Combution :-

The combution the first step is to burn in the furnace. the fuel can be any type of combustible material such as coal, oil, or natural gas. The combustion process creates hot gases, which are the source of heat for the boiler.

ii) Water heating :-

The hot gases from the furnace flow through the water tubes, heating the water inside the tubes The water tubes are made of a material that can withstand high temperatures, such as steel or copper. The water is heated until it reaches the boiling point, at which point it turns into steam.

iii) Steam separation :-

The steam rises to the steam drum, where it is separated from the water. The steam drum is a large vessel that is located at the top of the boiler.

iv) Water circulation :-

The remaining water flows back down to the furnace, where it is reheated and the process repeats. the water circulation process is driven by the difference in density between hot water and cold water. Hot water is less dense than cold water, so it rises to the boiler. This creates a circulation loop, with the hot water rising to the top and cold water flowing down to the bottom.

88) What are the advantages of using large capacity boilers ? Describe the operation of :(i) Velox Boiler (ii) Benson Boiler (iii) Lottler Boiler.

Ans:- Using large capacity boilers in industrial applications offers several advantage:-

1) Increase Efficiency :-

Large boilers can achieve higher efficiency due to better economies of scale. They can more effectly utilize fuel and energy inputs, leading to lower operating costs per unit of output.

2) Reduced operational costs :-

With economices of scale, larger boilers can often operate more efficiently and with fewer staff per unit of steam generated reducing labor costs.

3) Consistent steam supply :-

Large boilers can provide a steady and reliable supply of steam, which is crucial for continuous industrial process.

4) Space efficiency :-

Installing a single large boiler can be more space-efficient than installing multiple smaller boiler that collectively have the same capacity.

Operations :-

(i) Velox Boiler :-

The velox boiler is high pressure water tubes boiler. It work on principle similar to the LAMONT boiler but with a slight difference. In the Velox Boiler, the combution gases after heating the water in the boiler mix with a larger quantity of air and are passed through a series of tubes

where additional heat is transferred to the air. This Preheated air is then used to supply the necessary amount of air for the combustion of fuel in the burner. The mixture of fuel and air burns in a Combustion Chamber located in the centre of water tubes, generating high-Pressure Steam.

(ii) Benson Boiler:-

The Benson Boiler is a water tube boiler with forced circulation. It operates at supercritical pressure, which means that the water enters the boiler as a single-phase fluid above its critical pressure. This eliminates the need for a steam drum, as steam separation is achieved in the evaporator tubes themselves

(iii) Loeffler Boiler:-

The Loeffler Boiler is a high pressure water tube boiler with forced circulation. It works on the principle of evaporative heating by means of superheated steam. In a Loeffler Boiler, a feed pump supplies water to a Perforated tube. This water is mixed with steam from the evaporator drum. The mixture then enters the evaporator drum through NOZZle where it is heated by the hot gases from the furnace.

Q9) Write Advantage and Disadvantage of thermal Power Plant.

Ans:- Advatages:-

1) Reliable Power Generation:-

Thermal power plants provide a steady and reliable supply of electricity, which is crucial for meeting continuous demand.

2) Base Load Power :-

They are well-suited for providing base load power due to their ability to operate continuously and consistently.

3) Cost-Effective :-

Initial setup costs for thermal power plants can be lower compared to some renewable energy sources making them economically viable for electricity generation.

4) Energy Security :-

Thermal power plants can enhance energy security by providing a dependable source of electricity, reducing reliance on imported energy.

Disadvantages :-

1) Environmental Impact :-

Thermal power plants emit greenhous gases (such as CO_2) and pollutants (like sulfur dioxide and nitrogen oxide), contributing to air pollution and climate change.

2) Water Consumption :-

They required large amounts of water for cooling purposes, which can strain local water resources and ecosystems, particularly during droughts.

3) Resource Depletion :-

Fossil-fuel based thermal power plants contribute to the depletion of finite natural resources like coal, oil, and natural gas.

4) Land use :-

They occupy significant land areas, espesially when encluding storage for fuel and waste disposal,

Q10) Explain the general layout of ash handling (different system) and dust collection systems (classification) and draught (classification).

Ans:- Ash Handling Systems

Ash handling system are crucial in thermal power plants to manage the ash generated during combustion of coal or other fuels. There are typically two types of ash generated.

1) Bottom Ash:- This is heavy, coarse ash that falls to the bottom of the furnace.

2) Fly Ash :- This is fine, powdery ash that is carried up with the flue gases.

> General layout of Ash Handling Systems:-

- Bottom Ash Handling System:-

i) Ash Slurry Disposal System:-
Bottom ash is mixed with water to form slurry which is then transported through pipelines to ash disposal area such as ash ponds or ash dykes.

ii) Ash water Recovery System:-
This system recovers water from the ash slurry for reuse in the plant

- Fly Ash Handling System :-

1) Electrostatic precipitator (ESPs): Fly ash is [illegible] using electrostatic precipitators, which charge [illegible] particles and then collect them on grounded plates or electrodes.

ii) Mechanical Handling System:-
Fly Ash collected in ESP hoppers is transported by mechanical means to storage soils or disposal points

Dust Collection System :-

Dust Collection System are used to capture and remove Particulate matter (dust) from industrial processes, Preventing it from being released into the atmosphere.

Classification of Dust Collection Systems :-

1) Mechanical Cyclone :-

Cyclone Separators use centrifugal force to separate Particulates from gas steeam. They are effective for coarse dust particles.

2) Fabric Filers (Baghouse) :-

Baghouse use fabric bags made of cooven or felted material to capture dust particles

3) Inlet Scrubbers :-

Inlet scrubbers use water or other liquids to capture and remove dust particles from gas stream.

Draught System :-

Draught systems are used in boilers and furnaces to maintain the flow of gases and combution air, ensuring efficient combution and proper operation of the equipment.

Classification of Draught Systems :-

1) Natural Draught :-

Natural draught relies on the buoyancy of hot gases to create a flow through the chimney or stack.

2) Forced Draught :-

Forced draught system use fans or blowers to create a negative pressure in the furnace or boiler, drawing gases through and combustion product through the system.

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