Department of Electrical Engineering
Assignment
Date: 25/06/2020

Course Details

Course Title: Power Generation **Module:** 2nd
Instructor: Engr Sajid Nawaz **Total Marks:** 50

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Q1	How Electric Generation is Possible from Run off river and ocean wave.	**(10 marks)**
Q2	How Solar thermal Electric generation is possible.	**(10 marks)**
Q3	Discuss the situation of our current power generation from wind.	**(10 marks)**
Q4	Briefly explain the Nuclear power plant and also write down the merits and demerits of Nuclear power plant.	**(20 marks)**

Q1: How Electric Generation is Possible from Run off river and ocean wave.

Answer:

Run off river power generation:

Run-of-the-river hydroelectric systems are hydroelectric systems that harvest the energy from flowing water to generate electricity in the absence of a large dam and reservoir—which is how they differ from conventional impoundment hydroelectric facilities. A small dam may be used to ensure enough water goes in the penstock, and possibly some storage (for same day use). The primary difference between this type of hydroelectric generation compared to others is that run-of-the-river primarily uses the natural flow rate of water to generated instead of the power of water falling a large distance. However, water may still experience some vertical drop in a run-of-the-river system from the natural landscape or small dam. Another main difference between traditional hydropower is that run-of-the-river hydro is used in areas where there is little to no water storage, such as in a river.

There are several classifications of run-of-the-river systems, based primarily on their capacity. The types are outlined in the table below

Classification	Capacity
Micro	< 100 kW
Mini	100 kW - 1 MW
Small	1 - 50 MW

It is important to note that some larger scale run-of-the-river plants exist, with outputs of hundreds or thousands of MW.

Operation:

For a run-of-the-river system to be possible in a given location, there needs to be two specific geographical features. The first is there must be a reasonably substantial flow rate, either from rainfall or a melting snowpack. In addition, there must be enough of a tilt to the river to speed the water up significantly. Therefore, run-of-the-river systems are best implemented in bodies of water with a fairly constant flow rate. If they are built in locations where flow rate is fairly low for a period of time and then peaks dramatically, there will be a large amount of "wasted" water during the peak flow periods as the excess water falls through the spillways. This is because these systems are built to accommodate the lowest flow rate—thus, not be able to handle significantly larger flow rates.

In run-of-the-river systems, running water from a river is guided down a channel or penstock. There can be some change in altitude at this point (from a small dam or the natural landscape) so there may still be some contribution from "falling water." The diverted water is brought to an electricity generating house. In this house, the running water drives a turbine, running a generator and generating electricity. After being used, water is fed to the river downstream

Although run-of-the-river systems rely primarily on the flow rate of rivers to generate electricity and not a significant amount of water storage, some a small-scale dam or weir to ensure enough water enters the system itself. Pondage (a small amount of water stored behind the dam) is occasionally used, making them generally more reliable as they compensate for any discrepancies in water flow. This stored water isn't like a reservoir because it stores enough for "same day use" not future uses.

Generation from ocean waves:

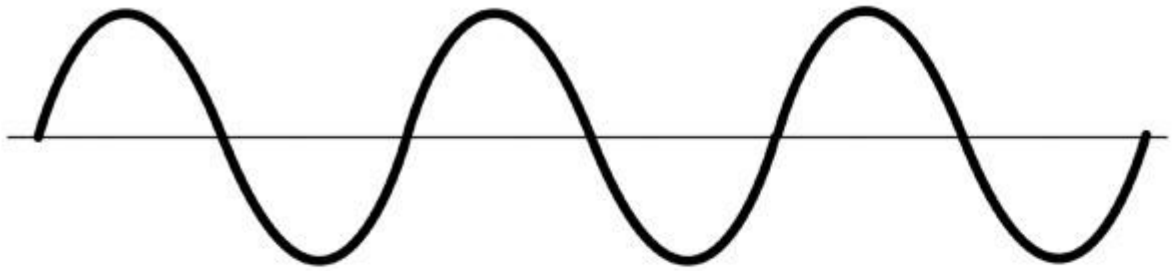
It divided in some steps:

1. Wind blows across the ocean, creating waves

The sun heats up air at different places around the globe, which creates wind that blows over ocean surfaces. The wind creates surface waves, like those that crash on a beach. The waves range in sizes (from ripples to nearly 100 feet tall) and can travel thousands of miles before they reach land with almost no energy loss.

2. Waves approach land

Regular waves, like radio or light waves, have a constant frequency and amplitude (see picture below). Ocean waves, on the other hand, interact with each other, the environment, and the weather. By the time a wave approaches land, it’s unlike any other. This is where researchers aim to extract the energy.



3. Waves encounter machines

Ocean waves are converted to electricity with wave energy converter, or WEC, devices. Researchers expect typical full-scale WEC devices to be anchored miles offshore in deep water where wave energy is strongest. Because WECs extract energy from waves of all sizes that move in multiple directions, identifying the type of machine that can most-effectively do this work is a key goal of the U.S. Department of Energy.

4. Machines convert waves into electricity

In short, ocean waves will move a WEC and that motion drives a generator that creates electricity. How machines take this motion of low-speed ocean waves with high energy content and convert them into the high-speed motion required for generators is not fully understood. Neither is how to do this economically and reliably, while also surviving harsh ocean conditions.

5. Electricity is applied to the grid or other needs

Wave energy could power swaths of coastal homes and businesses.

Wave energy is highly predictable and can be developed close to load centers to reduce transmission needs and ease integration onto the grid. Additionally, wave energy could power distributed applications in the near term, like desalination plants—which remove salt from salt water to benefit water-insecure communities and military bases.

Q2: How Solar thermal Electric generation is possible.

Answer:

Solar thermal electric generation:

Solar thermal power plants are electricity generation plants that utilize energy from the Sun to heat a fluid to a high temperature. This fluid then transfers its heat to water, which then becomes superheated steam. This steam is then used to turn turbines in a power plant, and this mechanical energy is converted into electricity by a generator. This type of generation is essentially the same as electricity generation that uses fossil fuels, but instead heats steam using sunlight instead of combustion of fossil fuels. These systems use solar collectors to concentrate the Sun's rays on one point to achieve appropriately high temperatures.

There are two types of systems to collect solar radiation and store it: passive systems and active systems. Solar thermal power plants are considered active systems. These plants are designed to operate using only solar energy, but most plants can use fossil fuel combustion to supplement output when needed.

Types of solar thermal power plants:

there are several different types of solar thermal power plants, they are all the same in that they utilize mirrors to reflect and concentrate sunlight on a point. At this point the solar energy is collected and converted to heat energy, which creates steam and runs a generator. This creates electricity.

Parabolic Troughs

These troughs, also known as line focus collectors, are composed of a long, parabolic shaped reflector that concentrates incident sunlight on a pipe that runs down the trough. The collectors sometimes utilize a single-axis Solar tracking system to track the Sun across the sky as it moves from east to west to ensure that there is always maximum solar energy incident on the mirrors. The receiver pipe in the center can reach temperatures upward of 400°C as the trough focuses Sun at 30-100 times its normal intensity.

These troughs are lined up in rows on a solar field. A heat transfer fluid is heated as it is run through the pipes in the parabolic trough. This fluid then returns to heat exchangers at a central location where the heat is transferred to water, generating high-pressure superheated steam. This steam then moves a turbine to power a generator and produce electricity. The heat transfer fluid is then cooled and run back through the solar field

Parabolic Dishes

These are large parabolic dishes that use motors to track the Sun. This ensures that they always receive the highest possible amount of incoming solar radiation that they then concentrate at the focal point of the dish. These dishes can concentrate sunlight much better than parabolic troughs and the fluid run through them can reach temperatures upwards of 750°C.

In these systems, a Stirling engine coverts heat to mechanical energy by compressing working fluid when cold and allowing the heated fluid to expand outward in a piston or move through a turbine. A generator then converts this mechanical energy to electricity

Solar Towers

Solar power towers are large towers that act as a central receiver for solar energy. They stand in the middle of a large array of mirrors that all concentrate sunlight on a point in the tower. These large number of flat, sun tracking mirrors are known as heliostats. In the tower, there is a mounted heat exchanger where the heat exchange fluid is warmed. The heat concentrated to this point can be 1500 times as intense as incident sunlight. The hot fluid is then used to create steam to run a turbine and generator, producing electricity. One drawback with these towers is they must be very large to be economical

Q3: Discuss the situation of our current power generation from wind.

Answer:

Electricity plays an important role in the socioeconomic growth and social prosperity of any country. It is to be considered as the basic need for human development. Nowadays, low production of electricity is a serious problem in Pakistan, which directly restricts the development of the state. One-third of Pakistan's population does not have any electricity in the rural areas and about 10–12 hours load shedding in urban areas and is quite common. Although, the state of Pakistan always shows a deficit in the conventional resources, but no progress was also being made in the renewable resources such as the wind and solar energy. Therefore, it is better to utilize these natural assets in order to fulfill the electricity supply the country. In this manuscript, our main objective is to study and outlooks the country energy profile situation vis-à-vis wind energy potential characteristics of the most important wind corridor in the southern part of the country. Pakistan has around 1100 kilometers (km) coastal line for the wind energy potential, but in this manuscript, we have chosen one of the most suitable wind corridors of the southern part of the country. We also tried to prove theoretically that this wind zone is more favorable for country consumer demand. Moreover, future perspective and the major challenges during windmill implementation.

Q4: Briefly explain the Nuclear power plant and also write down the merits and demerits of Nuclear power plant

Answer:

Nuclear power plant:

Nuclear power plants are a type of power plant that use the process of nuclear fission in order to generate electricity. They do this by using nuclear reactors in combination with the Rankine cycle, where the heat generated by the reactor converts water into steam, which spins a turbine and a generator. Nuclear power provides the world with around 11% of its total electricity, with the largest producers being the United States and France

Aside from the source of heat, nuclear power plants are very similar to coal-fired power plants. However, they require different safety measures since the use of nuclear fuel has vastly different properties from coal or other fossil fuels. They get their thermal power from splitting the nuclei of atoms in their reactor core, with uranium being the dominant choice of fuel in the world today. Thorium also has potential use in nuclear power production, however it is not currently in use. Below is the basic operation of a boiling water power plant, which shows the many components of a power plant, along with the generation of electricity.

Components and operation:

Nuclear Reactor

The reactor is a key component of a power plant, as it contains the fuel and its nuclear chain reaction, along with all of the nuclear waste products. The reactor is the heat source for the power plant, just like the boiler is for a coal plant. Uranium is the dominant nuclear fuel used in nuclear reactors, and its fission reactions are what produce the heat within a reactor. This heat is then transferred to the reactor's coolant, which provides heat to other parts of the nuclear power plant.

Besides their use in power generation, there are other types of nuclear reactors that are used for plutonium manufacturing, the propulsion of ships, aircraft and satellites, along with research and medical purposes. The power plant encompasses not just the reactor, but also cooling towers, turbines, generators, and various safety systems. The reactor is what makes it differ from other external heat engines.

Steam Generation

The production of steam is common among all nuclear power plants, but the way this is done varies immensely.

The most common power plants in the world use pressurized water reactors, which use two loops of circling water to produce steam. The first loop carries extremely hot liquid water to a heat exchanger, where water at a lower pressure is circulated. It then heats up and boils to steam, and can then be sent to the turbine section.

Boiling water reactors, the second most common reactor in power generation, heat the water in the core directly to steam.

Turbine and Generator

Once steam has been produced, it travels at high pressures and speeds through one or more turbines. These get up to extremely high speeds, causing the steam to loose energy, therefore, condensing back to a cooler liquid water. The rotation of the turbines is used to spin an electric generator, which produces electricity that is sent out the the electrical grid.

Cooling Towers

Perhaps the most iconic symbol of a nuclear power plant is the cooling towers, They work to reject waste heat to the atmosphere by the transfer of heat from hot water (from the turbine section) to the cooler outside air. Hot water cools in contact with the air and a small portion, around 2%, evaporates and raises up through the top. Moreover, these plants do not release any carbon dioxide—the primary greenhouse gas that contributes to climate change.
Click here to see how a cooling tower works.

Many nuclear power plants simply put the waste heat into a river, lake or ocean instead of having cooling towers. Many other power plants like coal-fired power plants have cooling towers or these large bodies of water as well. This similarity exists because the process of turning heat into electricity is almost identical between nuclear power plants and coal-fired power plants.

Efficiency:

The efficiency of a nuclear power plant is determined similarly to other heat engines—since technically the plant is a large heat engine. The amount of electric power produced for each unit of thermal power gives the plant its thermal efficiency, and due to the second law of thermodynamics there is an upper limit to how efficient these plants can be.

Typical nuclear power plants achieve efficiencies around 33-37%, comparable to fossil fueled power plants. Higher temperature and more modern designs like the Generation IV nuclear reactors could potentially reach above 45% efficiency.

ADVANTAGES OF NUCLEAR POWER PLANTS

There are lots of **advantages of nuclear power plant** as compared to other power plants.

1. Since the requirement of fuel is very small, so the cost of fuel transportation, storage etc. is small.

2. Nuclear power plant needs less space as compared to any other power station of the same size. Example: A 100 MW nuclear power station needs 38 - 40 acres of land whereas the same capacity coal based thermal power plant needs 120-130 acres of land.

3. This type of power plant is very economical to produce large electric power.

4. Nuclear power plant can be located near load centre because bulk amount of fuel (like water, coal) is not required.

5. Nuclear power is most economical to generate large capacities of power like 100 MVA or more. It produces huge amount of energy in every nuclear fission process.

6. Using a small amount of fuel, this plant produces large electrical energy.

7. This plant is very reliable in operation.

8. Since, the large number of nuclear fuel is available in this world. So, a nuclear power plant can generate electrical energy thousands of years continuously.

9. Nuclear Power Plant is very neat and clean as compared to a steam power plant.

10. The operating cost is low at this power plant but it is not affected for higher load demand. Nuclear power plant always operates a base load plant and load factor will not be less than 0.8.

DISADVANTAGES OF NUCLEAR POWER PLANTS

Though nuclear power plant has above advantages, but there are some **disadvantages of nuclear power plant** too,

1.Initial installation cost is very high as compared to the other power station.

2.Nuclear fuel is very much expensive and it is difficult to recover.

3.Capital cost is higher in respect of other power station.

4.Good technical knowledge is required to operate such type plant. So, salary bill and other maintenance cost will be higher to operate such of a plant.

5.There is a chance to spread of radioactive pollution from this type of plant.

6.Nuclear Reactor does not response efficiently with the fluctuating load demand. So, it is not suited for varying the load.

7.Cooling water requirement is twice than a coal based steam power plant.