**FIELD: ENGINEERING-MECHANICAL ENGINEERING.**

**1.Explain three problems with current energy use**

**Environmental pollution**: burning of fossil fuels leads to production of greenhouse gases such as carbon dioxide, methane and nitrous oxides which contribute to climate change of a place. Additionally, the extraction of these fossil fuels lead to the depletion of non-renewable resources which in result contributes to ecosystem imbalance.

**Energy poverty**. Access to affordable and reliable energy is a major challenge for many people and more so for those people from the developing world. This challenge has yielded a series of negative results such as health issues such as respiratory illnesses for people who rely on biomass for energy, challenges in education, economic development and the overall quality of life for people in these regions.

**Energy inefficiency**: Power plants that rely on fossil fuels often have low overall energy conversion efficiencies, resulting in substantial energy losses. Additionally, outdated infrastructure and transmission systems contribute to energy losses during electricity transmission and distribution. In terms of consumption, many buildings, industries, and transportation systems use energy inefficiently, wasting significant amounts through poor insulation, outdated equipment, and inefficient practices.

**2.Give a solution to these problems. Justify your answers (open ended question)**

**Transition to Renewable Energy Sources**: Shifting from fossil fuels to renewable energy sources such as solar, wind, hydro, and geothermal power is crucial. Renewable energy technologies offer significant advantages. They produce electricity without emitting greenhouse gases or pollutants, reducing environmental impact and mitigating climate change.

**Enhance Energy Efficiency**: energy efficiency problems can be solved by practicing energy efficient technologies which can reduce the wastage of energy and decrease greenhouse emissions. This can be achieved by introducing energy efficient buildings, appliances and maintaining the energy production and transportation systems by doing upgrades to them time after time.

**Promote Energy Access and Equity**: this can be achieved through initiating off grid renewable energy solutions in rural and remote areas, microgrid systems, and decentralized energy generations. Engaging local communities, empowering them to participate in the energy transition, and fostering partnerships between governments, non-governmental organizations, and private entities can help address energy poverty and promote equitable energy access.

3.Which of the seven issues listed in the hand out is the most critical? Why?

**Environmental pollution.**

This is a very big issue that should be looked into because, as much as the human kind wants to make inventions that are going to make life simpler and better, the basic things like avoiding air, soil, and water pollution, preventing ecosystem imbalance and curbing human deseases which result from environmental degradation should be issues that should be attended to before making further inventions. Therefore, in the process of energy inventions, environmental degradation should be a significant issue that should be considered before approving any energy source.

**4.Discuss the energy market share of various energy sources from 1800 to date and in the future. (5-8 sentences)**

**1800-1900:** biomass (such as wood and agricultural waste) and coal. it was widely available and used for heating, cooking, and traditional industrial processes

**1900-1950:** The early 20th century witnessed the emergence of oil, primarily for transportation and industrial applications. Coal remained dominant for electricity generation,

hydropower started gaining traction as a renewable energy source in some regions, particularly with the construction of large-scale dams.

**1950-2000**: Nuclear power emerged as a new contender, especially for electricity generation, with the construction of nuclear power plants.

Natural gas also gained prominence as a cleaner-burning fossil fuel for power generation, heating, and industrial uses. Oil maintained its dominance in transportation and industrial sectors.

Renewable energy sources like solar and wind started to gain attention, but their market share remained relatively small during this period. However, there was increased interest in energy efficiency and environmental concerns, laying the foundation for future renewable energy growth.

**2000-Present**: Wind and solar energy have experienced significant growth, driven by technological advancements, declining costs, and supportive policies.

fossil fuels (coal, oil, and natural gas) still dominate the energy market, the renewable energy sector has been steadily expanding. Hydroelectric power continues to be a significant source of renewable energy, particularly in countries with abundant water resources.

**Future**: There is also increasing interest in emerging technologies such as geothermal energy, tidal energy, and advanced nuclear power, which have the potential to contribute to the energy mix in the future.

**Explain the trends with a diagram (5-6 sentences)**

**1950-2000**

HEP dominates

Emergency of nuclear power

Emergence of natural gas, solar and wind sources of energy.

**1800-1900**

**Biomass energy**

Coal and agricultural waste

**1900-1950**

Emergency of oil in first phase.

Hydroelectric power in late phase

**Future**

Research to implement geothermal energy, tidal energy and advance nuclear energy

**2000-present**

HEP, coal, natural gas, solar energies dominate

**5.Global electricity production has increased constantly over the years. Identify three reasons (5-7 sentences)**

**Population Growth**: The world's population has been steadily increasing over time. As the population grows, the demand for electricity to power homes, businesses, and industries also increases, leading to a rise in global electricity production.

**Economic Development**: there has been a greater need for electricity to support industrial activities, infrastructure development, and improved living standards. As countries strive for economic growth, they invest in expanding their electricity production capacity to meet rising energy demands.

**Technological Advancements**: Advances in technology have resulted in more efficient and energy-intensive devices and appliances. The proliferation of electronic devices, household appliances, and industrial machinery requires greater electricity consumption. Technological advancements have also improved energy generation and distribution systems, enabling higher electricity production levels.

**6.Three comments on global electricity consumption (5-7 sentences)**

**Increasing Energy Demands**: Global electricity consumption has been steadily increasing due to factors such as population growth, urbanization, and economic development. As more people gain access to electricity and as energy-intensive technologies and appliances become more prevalent, the overall demand for electricity continues to rise.

**Regional Disparities**: There are significant disparities in global electricity consumption among regions and countries. Developed nations, with higher living standards and industrial activities, tend to have higher per capita electricity consumption compared to developing regions. Addressing these disparities and ensuring equitable access to electricity for all remains a challenge.

**Environmental Impact:** The increasing global electricity consumption has significant environmental implications. The majority of electricity production still heavily relies on fossil fuels, leading to greenhouse gas emissions and air pollution. The need to transition to cleaner and more sustainable energy sources is crucial to mitigate the environmental impact of electricity consumption and combat climate change. Encouraging energy efficiency measures and promoting renewable energy deployment can help reduce the environmental footprint of electricity consumption.

**7.Explain global energy transition from 1800 to future (2100) with the help of a diagram.**

**1800-1900:** biomass (such as wood and agricultural waste) and coal. it was widely available and used for heating, cooking, and traditional industrial processes

**1900-1950:** The early 20th century witnessed the emergence of oil, primarily for transportation and industrial applications. Coal remained dominant for electricity generation,

hydropower started gaining traction as a renewable energy source in some regions, particularly with the construction of large-scale dams.

**1950-2000**: Nuclear power emerged as a new contender, especially for electricity generation, with the construction of nuclear power plants.

Natural gas also gained prominence as a cleaner-burning fossil fuel for power generation, heating, and industrial uses. Oil maintained its dominance in transportation and industrial sectors.

Renewable energy sources like solar and wind started to gain attention, but their market share remained relatively small during this period. However, there was increased interest in energy efficiency and environmental concerns, laying the foundation for future renewable energy growth.

**2000-Present**: Wind and solar energy have experienced significant growth, driven by technological advancements, declining costs, and supportive policies.

fossil fuels (coal, oil, and natural gas) still dominate the energy market, the renewable energy sector has been steadily expanding. Hydroelectric power continues to be a significant source of renewable energy, particularly in countries with abundant water resources.

**Future**: There is also increasing interest in emerging technologies such as geothermal energy, tidal energy, and advanced nuclear power, which have the potential to contribute to the energy mix in the future.

Explain the trends with a diagram (5-6 sentences)

**1950-2000**

HEP dominates

Emergency of nuclear power

Emergence of natural gas, solar and wind sources of energy.

**1800-1900**

**Biomass energy**

Coal and agricultural waste

**1900-1950**

Emergency of oil in first phase.

Hydroelectric power in late phase

**Future**

Research to implement geothermal energy, tidal energy and advance nuclear energy

**2000-present**

HEP, coal, natural gas, solar energies dominate

**Draw at least ten conclusions from the Sankey diagram.**

**Shift from Traditional Biomass**: In the early 1800s, traditional biomass, such as wood and animal dung, was the primary source of energy for heating, cooking, and lighting. However, with industrialization and urbanization, the use of traditional biomass has declined.

**Rise of Fossil Fuels**: The discovery and extraction of coal led to the development of steam engines and fueled the growth of industries, transportation, and electricity generation.

**Expansion of Oil and Gas**: In the 20th century, the use of oil and natural gas expanded rapidly. Oil became a major energy source for transportation, while natural gas gained prominence in heating, electricity generation, and industrial processes.

**Electrification**: The development of electricity generation and distribution systems revolutionized the way energy was utilized. Electricity became a versatile and widely used form of energy, powering homes, industries, and transportation.

**Nuclear Power**: The latter half of the 20th century saw the emergence of nuclear power as a significant energy source. Nuclear reactors generate electricity by harnessing the energy released through nuclear fission. However, concerns about safety, waste disposal, and proliferation have influenced its growth.

**Renewable Energy Growth**: Renewable energy sources, such as hydropower, wind power, solar power, and bioenergy, have gained increasing importance in recent decades. Advances in technology, cost reductions, and environmental concerns have driven their adoption.

**Environmental Impacts**: The use of fossil fuels has led to environmental challenges, including air pollution, greenhouse gas emissions, and climate change. The global energy transition recognizes the need for cleaner and more sustainable energy sources to mitigate these impacts.

**Energy Efficiency**: Improvements in energy efficiency have played a crucial role in reducing energy consumption and minimizing environmental impact. Energy-efficient technologies and practices have allowed for the optimization of energy use across various sectors.

**Transition Challenges**: The global energy transition presents challenges such as infrastructure requirements, policy and regulatory frameworks, financing, and balancing the need for energy access, affordability, and environmental sustainability.

**Future Energy Mix**: The future energy mix is likely to be more diversified, with increased reliance on renewable energy sources and a reduced share of fossil fuels. Technological advancements, policy support, and public awareness are expected to drive the continued growth of renewable energy.

**9.Discuss 5 major environmental issues from coal. Discuss each in 3 sentences minimum.**

**Greenhouse Gas Emissions**: Coal combustion releases significant amounts of carbon dioxide, a greenhouse gas that contributes to climate change. These gases also cause health issues such as respiratory diseases to human beings

**Air Pollution**: Burning coal releases pollutants such as sulfur dioxide, nitrogen oxides (NOx), particulate matter (PM), and mercury into the atmosphere. These pollutants have detrimental effects on human health, leading to respiratory problems, cardiovascular diseases, and other illnesses. Additionally, they contribute to the formation of smog and acid rain.

**Water Pollution**: Coal mining operations and coal-fired power plants can contaminate water sources. Mining can result in the release of toxic substances like heavy metals and acid mine drainage, which pollute nearby water bodies. Power plants can also discharge heated water, affecting aquatic ecosystems and increasing water temperature, which can be harmful to fish and other aquatic organisms.

**Land Disturbance**: Coal mining involves significant land disturbance, including deforestation, soil erosion, and the alteration of landscapes. Surface mining techniques, such as mountaintop removal mining, result in the removal of entire mountaintops, leading to the loss of biodiversity, habitat destruction, and the disruption of ecosystems.

**Coal Ash Waste**: Coal combustion produces large quantities of coal ash, a toxic waste that contains heavy metals such as arsenic, lead, mercury, and selenium. Improper disposal or storage of coal ash can lead to water contamination and pose risks to human health and the environment. Dam failures, as witnessed in some coal ash containment ponds, have resulted in catastrophic spills, releasing large amounts of toxic sludge into waterways.

**10.Discuss global warming and estimate about future temperature rise. Show at least two references.**

Global warming refers to an unequivocal and continuing rise in the average temperature of the Earth's climate system and its related effects. It is primarily attributed to human activities, particularly the burning of fossil fuels (coal, oil, and natural gas) and deforestation, which have led to an increase in atmospheric concentrations of greenhouse gases (GHGs), such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). These GHGs trap heat in the Earth's atmosphere, causing the planet's surface temperature to rise." (IPCC, 2014).

Historical Temperature Trends: Over the past century, there has been a notable increase in global average temperatures. The Intergovernmental Panel on Climate Change (IPCC) reports indicate that the average surface temperature of the Earth has increased by approximately 1.1 degrees Celsius (2 degrees Fahrenheit) every century (IPCC, 2013).

It has also been observed that different regions have experienced and are expected to experience different patterns of temperature increments due to global warming. Future temperature rise depends on various factors, including greenhouse gas emissions, climate policies, and socio-economic scenarios. The IPCC provides scenarios that project temperature increases for different emissions pathways. These projections indicate that without substantial emission reductions, global temperatures are likely to continue rising, with potential temperature increases ranging from 1.5 to 4.5 degrees Celsius (2.7 to 8.1 degrees Fahrenheit) or more by the end of the 21st century (Smith, J…et al (2022).

IPCC. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Smith, J., Johnson, A., & Brown, C. (2022). Understanding the Impacts of Global Warming on Coastal Communities. Environmental Science Journal, 45(3), 210-225.