Attempt all the questions

Observe silence in the exam hall

1. Define the following:
   i. Energy – In physics, energy is the quantitative property that must be transferred to an object in order to perform work on, or to heat, the object. Energy is a conserved quantity; the law of conservation of energy states that energy can be converted in form, but not created or destroyed. The SI unit of energy is the joule, which is the energy transferred to an object by the work of moving it a distance of 1 metre against a force of 1 newton. Common forms of energy include the kinetic energy of a moving object, the potential energy stored by an object's position in a force field (gravitational, electric or magnetic), the elastic energy stored by stretching solid objects, the chemical energy released when a fuel burns, the radiant energy carried by light, and the thermal energy due to an object's temperature.
   ii. Mass – Mass is both a property of a physical body and a measure of its resistance to acceleration (rate of change of velocity with respect to time) when a net force is applied. An object's mass also determines the strength of its gravitational attraction to other bodies. The SI base unit of mass is the kilogram (kg). In physics, mass is not the same as weight, even though mass is often determined by measuring the object's weight using a spring scale, rather than balance scale comparing it directly with known masses. An object on the Moon would weigh less than it does on Earth because of the lower gravity, but it would still have the same mass. This is because weight is a force, while mass is the property that (along with gravity) determines the strength of this force.
   iii. Power – In physics, power is the amount of energy transferred or converted per unit time. In the International System of Units, the unit of power is the watt, equal to one joule per second. In older works, power is sometimes called activity. Power is a scalar quantity. The rate at which a light bulb converts electrical energy into light and heat is measured in watts – the electrical energy used per unit of time.
   iv. Biomass – Biomass is plant or animal material used as fuel to produce electricity or heat. Examples are wood, energy crops and waste from forests, yards, or farms. Since biomass technically can be used as a fuel directly (e.g., wood logs), some people use the terms biomass and biofuel interchangeably. More often than not, the word biomass simply denotes the biological raw material the fuel is made of. The word biofuel is usually reserved for liquid or gaseous fuels, used for transportation.
   v. Weather – Weather is the state of the atmosphere, describing for example the degree to which it is hot or cold, wet or dry, calm or stormy, clear or cloudy. Weather refers to day-to-day temperature and precipitation activity. Weather is

driven by air pressure, temperature, and moisture differences between one place and another.

vi. Climate – is commonly defined as the weather averaged over a long period. The standard averaging period is 30 years, but other periods may be used depending on the purpose. Climate also includes statistics other than the average, such as the magnitudes of day-to-day or year-to-year variations

vii. A desert is a landscape form or region that receives very little precipitation. Deserts usually have a large diurnal and seasonal temperature range, with high or low, depending on location daytime temperatures (in summer up to 45 °C or 113 °F), and low nighttime temperatures (in winter down to 0 °C or 32 °F) due to extremely low humidity.

viii. Building-integrated photovoltaics (BIPV) – These are photovoltaic materials that are used to replace conventional building materials in parts of the building envelope such as the roof, skylights, or facades.

ix. Energy audit - An energy audit is an inspection survey and an analysis of energy flows for energy conservation in a building. It may include a process or system to reduce the amount of energy input into the system without negatively affecting the output. In commercial and industrial real estate, an energy audit is the first step in identifying opportunities to reduce energy expense and carbon footprint.

x. Green building - (also known as green construction or sustainable building) refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition.

2. Name and discuss SIX Factors influencing the energy use in building

i. **Local material**: In the total energy consumption of constructions, the amount of energy spent for transportation of the construction materials to construction sites is considerable and also affects the constructions' energy efficiency and economical cost. For this reason, if the construction materials are local material and are manufactured in nearby places to the construction site as much as possible, energy consumption in transportation will decrease and that saving in transportation will give the construction an important ecological quality.

ii. **Recycled resources**: A large amount of energy is used in manufacturing many building materials. In the manufacture of building material, using recycled sources instead of the sources which are not newly processed material provides a considerable

preservation of raw material and also a considerable amount of energy saving. Recycling building materials are essential to reduce the embodied energy in the building

iii. **Materials manufactured through low density industrial processes**: Building materials play a significant role in the energy efficiency of buildings. A large proportion of the total energy used during the building life cycle is consumed during the production of building materials (especially embodied energy).

iv. **Natural materials that are quickly obtained from renewable resources**: Generally, the energy content of natural materials is lower than that of artificial materials since these materials are manufactured with less energy and labour cost. Such kinds of materials which are easy to be locally provided are generally among the renewable resources. Such vegetal materials used in constructions for instance, wood, bamboo, reed, straw, rye stalk, sunflower stalk, mushroom are the natural materials which are quickly gained from renewable sources.

v. **Labour intensive materials**: Using highly qualified man power in manufacturing materials will reduce the processes based upon industry, and accordingly decrease the energy consumption. Materials manufactured by using renewable energy resources: especially renewable energy resources (solar energy, wind energy, etc.) instead of fossil fuels should be preferred as a primary energy supplier in the manufacturing process.

vi. **Materials consuming less energy during the worksite process**: The management of worksite, the need for electricity energy, and machines in operation, heating, and lightening affect the energy consumption of the worksite. As a result of the increase in mechanization in worksites, the electricity consumption has increased considerably as well.

vii. **Use of durable building materials**: Use of durable materials in the buildings makes them more resistant and long-lasting against various factors. This delays or eliminates the need of renewing material or maintenance due to impairment and aging. In this way, it is saved from the energy spent for the material to be used in maintenance or renewing.

viii. **Building materials with high thermal insulation capacity**: With the choice of building materials whose thermal insulation capacity is high, the energy amount that the construction consumes in its usage stage will be decreased. As mentioned as examples are opaque and translucent insulating materials.

3. Discuss how energy efficient buildings should be designed in the following classification of climate

   i. **Temperate climate**: It should maximize warming effects of the sun in winter and maximize shade during the summer. Buildings should be protected away from winter winds. Summer breezes should be directed toward the buildings. Constantly green trees with low branches to protect them from the cold winter winds on the northern front, low shrubs or trees not high, should be applied on the south front, high body deciduous trees should be placed on the eastern and western facades for block the sun and allowing natural ventilation.
   ii. **Hot-arid climate**: It provides shade to cool roofs, walls, and windows. Allows summer winds to access naturally cooled homes and blocks or deflect winds away from air-conditioned homes. North and south sides should avoid forestation, while the eastern and western direction (positioning studies may be substituted), shrubs, vines have been placed on the walls and deciduous trees should be implemented.
   iii. **Hot-humid climate**: Channel summer breezes toward the home. Maximize summer shade with trees that still allow penetration of low-angle winter sun. Avoid locating planting beds close to the home if they require frequent watering. Should avoid forestation on the southern front, in the northern front, forestation should be done providing the shadow effect in summer. The eastern and western direction, shrubs, and vines have been placed on the walls and deciduous trees should be implemented.
   iv. **Cool climate**: Use dense windbreaks to protect the building from cold winter winds. Allow the winter sun to reach south-facing windows. If summer overheating is a problem, shade south and west windows and walls from the direct summer sun. The north façade is useful in cold climate regions partly

raised land application. Northern, eastern, and western fronts in constantly green shrubs and the green, the low branches of trees should be preferred. In the southern wind breaker, low shrubs and grass should be applied. In southeast and southwest direction away from the building, deciduous trees should be used.

4. State the four main four climatic zones of Kenya:

    i. Hot and Dry
    ii. Warm and Humid
    iii. Moderate
    iv. Cold

5. The heat flow due to radiation and air movement can be controlled by varying the following aspects of the building configuration. Explain each of them.
    i. **Surface area to volume ratio (S/V ratio):** The ratio of the surface area to the volume of the building (S/V ratio) determines the magnitude of the heat transfer in and out of the building. The larger the S/V ratio, the greater the heat gain or loss for a given volume of space. Conversely, a smaller S/V ratio will result in the reduction of heat gain/loss. For example, in cold climates it is preferable to have compact house forms with minimum S/V ratio.
    ii. **Shape of the building:** Wind when obstructed by a building creates pressure differences, that is, positive pressure on the windward side and negative pressure on the leeward side. Consequently, a new airflow pattern is established around the building. Thus, wind pattern across a building can be modified by shaping it appropriately.
    iii. **Buffer spaces:** Buffer spaces such as courtyards, atria, balconies and verandas provide shading and catch wind.
    iv. **Arrangement of openings:** Appropriate openings connecting high- and low-pressure areas provide effective ventilation. Solid and glazed surfaces need to be suitably arranged and oriented for receiving or rejecting solar radiation.

6. Energy can be classified into two categories; Renewable and Non-Renewable. Briefly explain.

Renewable sources of energy are those that are inexhaustible, such as the energy from the sun, wind, waves and tides, and geothermal heat. Non-Renewable sources of energy are those that are exhaustible and cannot be quickly replaced, such as fossil fuels and biomass.

7. What do you understand by the term Efficient energy use –

   This, sometimes simply called energy efficiency, is the goal to reduce the amount of energy required to provide products and services and can also reduce effects of air pollution. For example, insulating a building allows it to use less heating and cooling energy to achieve and maintain a thermal comfort