GUJARAT TECHNOLOGICAL UNIVERSITY

BE-4 SEMESTER – S22 TO W25 – QUESTION BANK SOLUTION

Subject Name & Code:

ENVIRONMENTAL SCIENCE, SUSTAINABILITY AND RENEWABLE ENERGY- BE04000101

Note on Question Sources: This question bank is compiled from old GTU subjects (3110007 Environmental Sciences & 3161914 Renewable Energy Engineering) and the ESSRE list. Since the new syllabus (BE04000101) started in 2024-25, no direct previous papers exist. These questions are the **best available match** to the new syllabus topics and sub-topics.

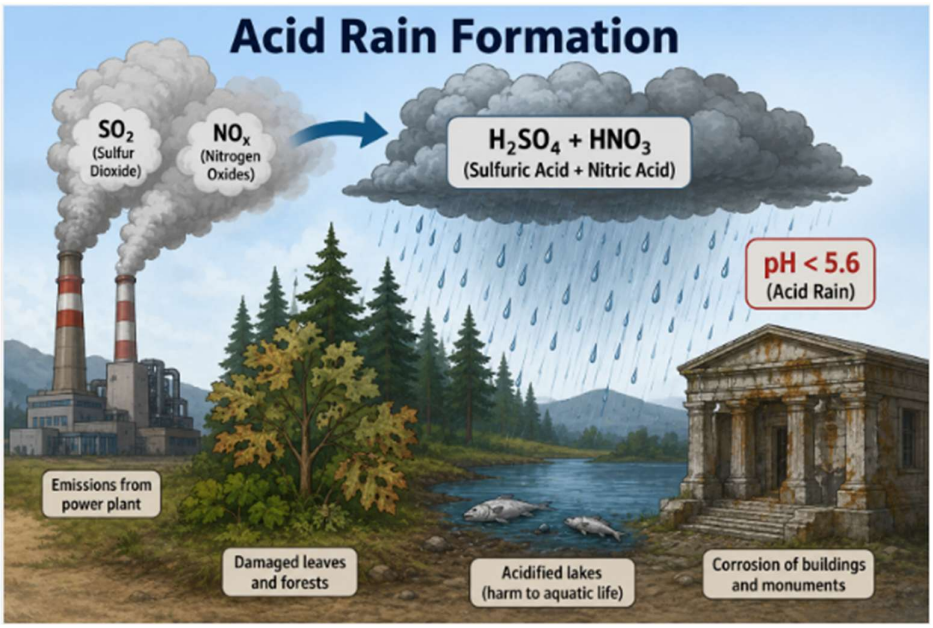
Unit 3 – Sustainability

Q. Write a short note on acid rain. (7 marks – appeared 2+ times)

Ans:

- **Definition:** Rain with pH <5.6 due to presence of H_2SO_4 and HNO_3.
- **Formation:**
  $SO_2 + H_2O \rightarrow H_2SO_3 \rightarrow H_2SO_4$
  $NOx + H_2O \rightarrow HNO_3$
- **Effects:** (see Unit 2 acid rain)
- **Control:** FGD, SCR, electric vehicles, renewable energy.

Diagram:



Q. Explain ozone layer depletion. (7 marks – appeared 3+ times)

Ans:

- **Ozone layer:** Stratospheric layer (15-35 km) absorbing 97-99% UV-B and UV-C.
- **Depletion cause:** Chlorofluorocarbons (CFCs), halons, carbon tetrachloride – used in refrigerants, aerosols, fire extinguishers.
- **Mechanism:**
  UV breaks CFC → Cl atom.
  $Cl + O_3 \rightarrow ClO + O_2$.
  $ClO + O \rightarrow Cl + O_2$ (Cl regenerated, destroys 100,000 O_3 molecules).

- **Effects:** Increased UV → skin cancer, cataracts, weakened immune system, reduced phytoplankton (marine food chain collapse).
- **Montreal Protocol (1987):** Phase out ODS – success story: hole over Antarctica is slowly healing.

Example: India phased out CFCs by 2010 under Montreal Protocol.

Q. Describe the applications of the 4R principle with example. (7 marks – appeared 2+ times)
Ans:

- **4R:** Reduce, Reuse, Recycle, Recover.

R	Application	Example
Reduce	Use less resources, generate less waste	Buy loose vegetables instead of plastic-packaged
Reuse	Use item again for same/different purpose	Glass bottle refilled with water; old jars for storage
Recycle	Convert waste into new material	PET bottles → polyester fleece jacket
Recover	Extract energy from waste	Landfill gas (methane) to electricity

Real-world urban example: Indore city (India) – 4R implementation reduced landfill waste by 60% and generates 15 MW from recovered gas.

Q. Explain the need of the 4R concept for waste minimization. (7 marks)
Ans:

- **Need:**
  - Landfills are overflowing and polluting groundwater.
  - Incineration releases toxic gases (dioxins, furans).
  - Raw materials are finite (mining depletes resources).
  - Circular economy reduces carbon footprint.
- **How 4R helps:**
  - Reduce → prevents waste generation at source.
  - Reuse → extends product life, saves embodied energy.
  - Recycle → reduces virgin material extraction.
  - Recover → extracts value from residual waste.

Example: Japan's *3R* (plus 'Recover') policy achieved 20% reduction in final disposal.

Q. Explain the fundamental principles of green building. (7 marks – appeared 2+ times)
Ans:

- **Site selection & planning:** Preserve existing vegetation, orient building for natural light/wind.
- **Water efficiency:** Low-flow fixtures, rainwater harvesting, wastewater recycling (ZLD).
- **Energy efficiency:** Solar PV, passive cooling, LED lighting, high-performance insulation.

- **Material selection:** Recycled, locally sourced, low-VOC, durable materials (fly-ash bricks, bamboo).
- **Indoor environmental quality:** Natural ventilation, daylight, air quality monitoring.
- **Waste management:** Segregation onsite, construction debris recycling.

Example: Suzlon One Earth (Pune) – LEED Platinum, 100% renewable energy, 80% water recycling.

Q. Explain different green building rating systems. (7 marks)
Ans:

System	Origin	Focus	Rating levels
LEED (Leadership in Energy & Environmental Design)	USA	Energy, water, materials, indoor quality	Certified, Silver, Gold, Platinum
GRIHA (Green Rating for Integrated Habitat Assessment)	India (TERI)	National priority – climate, passive design	1 to 5 stars
BREEAM	UK	Management, health, transport, ecology	Pass, Good, Very Good, Excellent, Outstanding
IGBC (Indian Green Building Council)	India	Similar to LEED, adapted to India	Silver, Gold, Platinum

Real example: The Indira Paryavaran Bhawan (Delhi) is GRIHA 5-star and net-zero energy.

Q. Discuss the benefits of calculating carbon footprints. (3 marks – appeared 2+ times)
Ans:

- Identifies major emission sources (electricity, transport, waste).
- Helps set reduction targets (e.g., 50% reduction by 2030).
- Compares products/processes to choose greener options.
- Enhances brand image and attracts investors.
- Compliance with carbon trading (CDM) and CSR reporting.

Example: A company calculating its carbon footprint realizes 70% emissions from diesel generators – then switches to grid solar saving 500 tCO_2/year.

Q. Define green building and state its objectives. (4 marks – appeared 2+ times)
Ans:

- **Definition:** A building that uses environmentally responsible and resource-efficient processes throughout its life cycle – design, construction, operation, maintenance, renovation, demolition.
- **Objectives:**
  - Reduce energy & water consumption.
  - Minimize waste and pollution.
  - Enhance occupant health and productivity.
  - Lower life-cycle cost.

Example: A green building harvests rainwater, uses solar water heating, and has a terrace

garden.

Q. Write a brief note on the concept of a smart city. (4 marks – appeared 2+ times)
Ans:

- **Definition:** A city that uses digital technology and data analytics to improve infrastructure, services, sustainability, and quality of life.
- **Components (as per India Smart City Mission):**
  - Smart energy (smart grid, solar rooftops)
  - Smart mobility (EV charging, integrated traffic management)
  - Smart water (leak detection, quality monitoring)
  - Smart waste (IoT bins, RFID tracking)
  - Citizen participation (mobile apps, dashboards)

Example: Ahmedabad's Smart City project includes intelligent traffic signals and command control center.

Q. Enlist features/core infrastructure elements of a smart city. (4 marks – appeared 2+ times)
Ans:

- Adequate water supply & rainwater harvesting
- Assured electricity supply (solar/wind integration)
- Sanitation & solid waste management
- Efficient public transport and traffic management
- Affordable housing & robust IT connectivity (Wi-Fi, fiber)
- Safety (CCTV, emergency response)
- e-Governance & citizen participation

Q. Explain the concept of Clean Development Mechanism (CDM). (7 marks)
Ans:

- **Definition:** A Kyoto Protocol mechanism allowing developed countries to earn carbon credits by funding emission-reduction projects in developing countries.
- **Process:**
  1. Project (e.g., solar farm in India) reduces emissions by X tonnes CO_2e.
  2. CDM certifies *Certified Emission Reductions (CERs)* – 1 CER = 1 tonne CO_2e.
  3. Developed country buys CERs to meet its emission targets.
- **Benefits:**
  - Developing countries get investment & technology.
  - Cost-effective global emission reduction.

Example: Suzlon's wind energy project in Maharashtra registered as CDM – sold CERs to European utilities.

Q. Distinguish between primary and secondary carbon footprint. (4 marks)
Ans:

Type	Definition	Examples
Primary	Direct emissions from sources owned/controlled by an individual/organization	Petrol in personal car, natural gas for heating, fugitive refrigerants
Secondary	Indirect emissions from production and	Electricity, food, clothes, air travel

Type	Definition	Examples
	transport of purchased goods/services	(Scope 3 for companies)

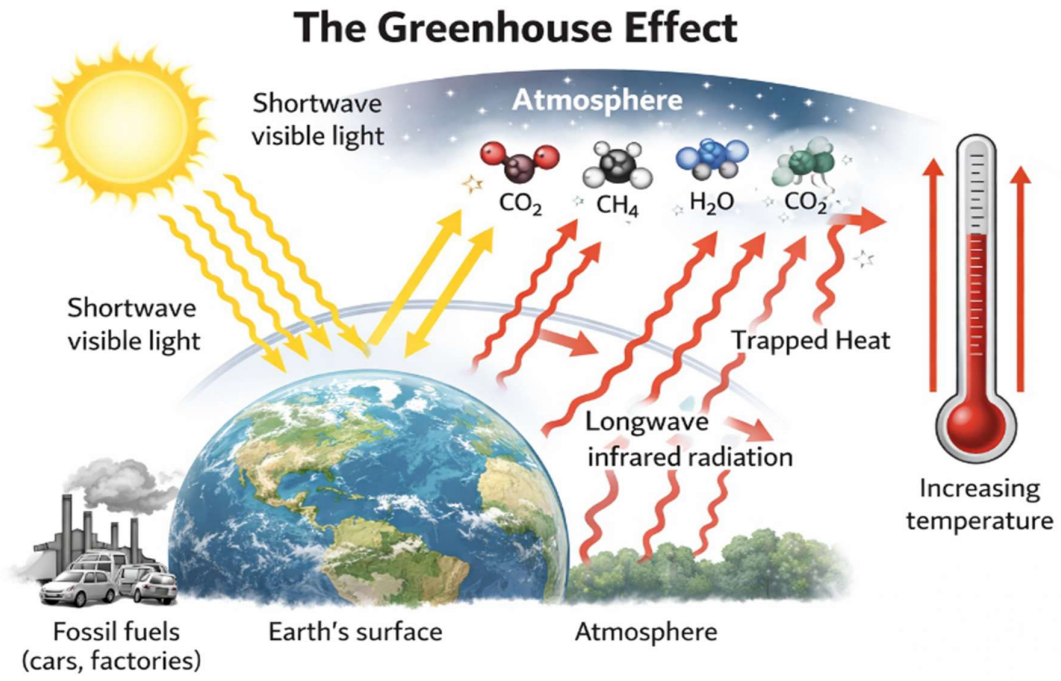
Example: Driving your car (primary) vs. buying imported apples (secondary due to shipping emissions).

Q. What is the greenhouse effect? Discuss various greenhouse gases. (7 marks)
Ans:

- **Greenhouse effect:** Natural process where certain gases trap heat in Earth's atmosphere, keeping average temperature ~15°C instead of –18°C.
- **Enhanced greenhouse effect:** Human activities increase GHG concentration → global warming.

Gas	Sources	GWP (100 yr)	Contribution
CO_2	Fossil fuel burning, deforestation	1	76% of warming
CH_4 (methane)	Agriculture (rice, livestock), landfills	28	16%
N_2O (nitrous oxide)	Fertilizers, industrial processes	265	6%
F-gases (HFCs, PFCs, SF_6)	Refrigerants, aerosols	Thousands	2%

Diagram:



Q. List international steps for mitigation of global change. (3 marks)
Ans:

- **Montreal Protocol (1987)** – phase out ODS (ozone depleting substances).
- **Kyoto Protocol (1997)** – legally binding emission reduction targets for developed countries.
- **Paris Agreement (2015)** – limit global warming to <2°C, preferably 1.5°C.
- **COP conferences** – annual UN meetings to review progress.
- **Sustainable Development Goals (SDGs)** – especially SDG 13 (Climate Action).

Example: India submitted NDCs (Nationally Determined Contributions) under Paris Agreement.

Q. Explain the benefits of green buildings. (7 marks – appeared W22 Q5c)
Ans:

Benefit Category	Details
Environmental	30-50% less water use, 20-30% less energy, reduced CO_2 emissions, less construction waste
Economic	Lower utility bills, higher property value, lower maintenance costs, government incentives
Social/Health	Better indoor air quality, more natural light, thermal comfort → increased productivity, reduced sick days
Operational	Easier waste segregation, rainwater harvesting, renewable energy integration

Real-world example: Infosys campus, Mysore – green buildings saved ₹12 crore annually in electricity costs.

Q. Differentiate between recycle and reuse with example. (3 marks – appeared S22 Q3a OR)
Ans:

Parameter	Reuse	Recycle
Definition	Using an item again for same/different purpose without processing	Processing waste into new raw material or product
Energy input	Low (just cleaning/repair)	High (melting, shredding, chemical treatment)
Example	Refilling a glass water bottle	Melting glass bottles to make new bottles or fiberglass

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Q. Differentiate between recycle and recover. (4 marks – appeared W22 Q3b)
Ans:

Parameter	Recycle	Recover

Parameter	Recycle	Recover
Output	New material/product	Energy (heat, electricity, fuel)
Process	Mechanical/chemical conversion	Combustion, gasification, anaerobic digestion
Example	Old newspapers → paper pulp → new notebooks	Landfill methane → electricity generation
Priority in waste hierarchy	Higher (3rd R)	Lower (4th R – last option before disposal)

Q. Give an example of how the 4R principles can be applied in a household. (3 marks – appeared S23 Q5a)
Ans:

- **Reduce:** Buy loose vegetables instead of pre-packed in plastic; repair leaky taps.
- **Reuse:** Use old t-shirts as cleaning rags; glass jars for storing spices.
- **Recycle:** Segregate plastic, paper, glass → send to kabadiwala/ recycling bin.
- **Recover:** Compost kitchen waste (fruit peels, eggshells) to recover nutrients for garden.

Q. Define sustainability and circular economy. (3 marks – Excel file)
Ans:

- **Sustainability:** Meeting present needs without compromising the ability of future generations to meet their own needs (Brundtland Commission).
- **Circular economy:** An economic system where resources are kept in use as long as possible, maximum value extracted, then materials recovered and regenerated – opposite of linear "take-make-dispose".

Example: A circular economy business leases washing machines and takes back old ones for refurbishing – zero waste.

Q. Describe the concept of the 4R's with practical examples. (3 marks – Excel file)
Ans:

R	Practical example
Reduce	Print double-sided to save paper
Reuse	Carry a cloth bag to market
Recycle	Drop used PET bottles at collection center
Recover	Use a biogas plant for cow dung to get cooking gas

Q. Explain the role of Sustainable Development Goals (SDGs) in engineering projects. (4 marks – Excel file)
Ans:

- **SDG 6 (Clean water & sanitation):** Engineers design water treatment plants & sewage systems.
- **SDG 7 (Affordable & clean energy):** Solar, wind, hydro projects directly contribute.
- **SDG 9 (Industry, innovation & infrastructure):** Green buildings, smart cities.
- **SDG 11 (Sustainable cities):** Public transport, waste management systems.
- **SDG 12 (Responsible consumption):** 4R implementation in factories.
- **SDG 13 (Climate action):** Carbon footprint reduction in designs.

Example: A highway project includes wildlife corridors (SDG 15) and solar lighting (SDG 7).

Q. Apply the concept of 4R's to reduce waste in a college campus. (4 marks – Excel file)
Ans:

- **Reduce:** Ban single-use plastic canteen items; digital notices instead of paper.
- **Reuse:** Refillable water stations; reuse printed one-side paper for scratch pads.
- **Recycle:** Separate bins for paper, plastic, glass; tie-up with local recycler.
- **Recover:** Compost food waste from canteen for campus gardening; e-waste collection drive.

Example: IIT Bombay's waste management cell reduces landfill waste by 70% using 4R.

Q. Explain with examples how green buildings contribute to sustainability. (4 marks – Excel file)
Ans:

- **Energy:** Solar panels reduce fossil fuel use → lowers CO_2. *Example:* CISL building, Bangalore.
- **Water:** Rainwater harvesting recharges groundwater.
- **Materials:** Fly-ash bricks reduce cement consumption (cement = high CO_2).
- **Waste:** Construction debris recycled into new blocks.

Result: Green buildings have 40-50% lower environmental impact than conventional.

Q. Compare traditional building practices with green building principles. (4 marks – Excel file)
Ans:

Aspect	Traditional	Green
Energy source	Grid electricity (often coal)	Solar, wind, passive design
Water	Municipal supply only	Rainwater harvesting + wastewater recycling
Materials	High embodied energy (cement, steel)	Recycled, local, low-VOC
Waste	Mixed construction debris to landfill	Segregated, recycled onsite
Indoor air	Often poor ventilation	Natural ventilation, air filtration

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Q. Analyze the impacts of climate change on agriculture. (4 marks – Excel file)

Ans:

- **Temperature rise:** Heat stress reduces wheat, rice yields (6-10% per 1°C increase).
- **Erratic rainfall:** Floods destroy crops; droughts reduce irrigation.
- **Sea level rise:** Saline intrusion in coastal farmlands (e.g., Sundarbans).
- **Pests & diseases:** Warmer climate expands pest range (e.g., locusts, stem borer).
- **CO_2 fertilization effect:** Some crops (wheat, rice) may grow faster but with lower protein.

Example: Punjab's wheat yield dropped 15% in 2022 due to unseasonal heatwave.

Q. Assess the effectiveness of climate change mitigation strategies adopted globally. (7 marks – Excel file)

Ans:

- **Renewable energy shift:** Solar & wind now cheaper than coal – effective but slower than needed.
- **Reforestation & afforestation:** China's Great Green Wall – reduced desertification but not enough carbon capture.
- **Carbon pricing (tax & trading):** EU ETS reduced industrial emissions 37% since 2005 – effective.
- **Electric vehicles:** Norway's 80% EV new sales – very effective, but charging infrastructure gap in developing countries.
- **Phase out of HFCs (Kigali Amendment):** Expected to avoid 0.5°C warming – highly effective.

Limitations: Global CO_2 still rising; mitigation strategies need stricter enforcement and faster scaling.

Example: India's LED bulb scheme (UJALA) saved 40 billion kWh/year – a small but effective mitigation.

Q. Justify the importance of SDGs in engineering solutions. (7 marks – Excel file)

Ans:

- SDGs provide a **holistic framework** – not just technical performance but social equity and environmental limits.
- For engineers:
  - **SDG 7 & 13** drive renewable energy & low-carbon designs.
  - **SDG 6 & 11** require water/sanitation & sustainable cities expertise.
  - **SDG 12** demands waste minimization (4R) in manufacturing processes.
  - **SDG 9** encourages resilient infrastructure.
- **Justification:** Without SDG alignment, engineering projects may solve one problem but worsen another (e.g., dam provides power but displaces communities – failing SDG 10).

Real-world: The Gujarat International Finance Tec-City (GIFT) integrated SDGs into its design (water recycling, district cooling, EV charging).

Q. Propose a sustainable waste management plan for a mid-sized engineering college campus (1000 students). (7 marks – Excel file)

Ans:

Step 1: Waste audit – measure daily generation (kg/day) of food waste, paper, plastic, e-waste, general waste.

Step 2: Infrastructure

- Colour-coded bins at every floor & canteen (green: organic; blue: recyclable; red: hazardous like batteries; black: general).

- Central composting unit for food/garden waste (capacity 200 kg/day).
- E-waste collection box near library, sent to authorised recycler quarterly.
- Plastic bottle crusher at sports complex.

Step 3: 4R implementation

- **Reduce:** Digital attendance & assignments; ban plastic water bottles (install RO refill stations).
- **Reuse:** Donate old uniforms/textbooks to junior students; refillable pens.
- **Recycle:** Tie-up with local kabadiwala for paper & plastic; sell to recycler.
- **Recover:** Biogas plant from 500 kg/day canteen waste → cooking fuel for canteen.

Step 4: Awareness – workshops, posters, Swachhata drive every semester.
Step 5: Monitoring – Eco-club monthly reporting; target: 80% diversion from landfill in 2 years.
Example: NIT Trichy's waste management plan diverts 75% waste through composting & recycling.

Q. Propose a green building design for an engineering laboratory. (7 marks – Excel file)
Ans:
1. Site & orientation: North-south facing long axis, shaded south windows, maximise north light.
2. Passive design:

- High thermal mass (hollow concrete blocks) + double-glazed windows.
- Roof insulation (thermocol + reflective paint).
- Cross-ventilation with operable louvers.

3. Active systems:

- Solar PV (10 kWp) on roof → powers lights, fans, small equipment.
- Solar water heater for lab wash areas.
- LED lighting + daylight sensors.

4. Water efficiency:

- Rainwater harvesting (roof runoff to recharge well).
- Low-flow faucets; greywater from lab sinks (non-toxic) to garden irrigation after treatment.

5. Materials:

- Fly-ash bricks, recycled steel, low-VOC paints.
- Bamboo windowsills, recycled plastic benches.

6. Indoor quality: CO_2 sensors, exhaust hoods for chemical labs, ample daylight (>50% workstations within 7m of window).
7. Waste: Separate hazardous chemical waste storage; e-waste bin.
Example: IIT Gandhinagar's Mechanical Lab building – GRIHA 4-star with 30% energy saving.

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