	b)	Apply energy modeling techniques to evaluate the HVAC system requirements for a commercial building.	L3	CO4	5 M
		OR			
9	a)	Critically analyze the role of cooling towers in optimizing water and energy use in HVAC systems.	L4	CO4	5 M
	b)	Apply lighting design principles to propose an energy-efficient interior lighting system for a modern office space.	L3	CO4	5 M
		UNIT-V			
10	a)	Analyze how non-process waste handling can be improved at construction sites to minimize environmental impact.	L4	CO5	5 M
	b)	Evaluate the balance between energy efficiency and IAQ requirements in modern HVAC system design.	L5	CO5	5 M
		OR			
11	a)	Evaluate various strategies to achieve acceptable IAQ levels in densely populated office spaces.	L5	CO5	5 M
	b)	Evaluate the occupational health risks associated with Sick Building Syndrome.	L5	CO5	5 M

Code: 23CE2501

PVP 23

III B.Tech - I Semester - Regular Examinations - NOVEMBER 2025

GREEN BUILDINGS

(Common for ALL Branches)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	Define Green Buildings.	L1	CO1
1.b)	Mention any two Green Building rating systems applicable in India.	L1	CO2
1.c)	Who developed and supported the GRIHA rating system?	L1	CO2
1.d)	Name two typical energy-saving approaches for buildings in India.	L2	CO3
1.e)	Name few passive design strategies and active design systems.	L2	CO3
1.f)	What are the types of renewable energy sources?	L1	CO3
1.g)	List the critical steps in HVAC design.	L2	CO4
1.h)	What are the strategies for energy-efficient interior lighting?	L2	CO4
1.i)	What are the measures to improve IAQ?	L2	CO5
1.j)	Why certified wood is preferred in green buildings?	L2	CO5

PART – B

			BL	CO	Max. Marks
		UNIT-I			
2	a)	Explain why India needs to adopt Green Buildings in the context of climate change and rapid urbanization.	L2	CO2	5 M
	b)	Analyze the social, environmental, and economic benefits of Green Buildings with examples.	L4	CO1	5 M
		OR			
3	a)	Explain briefly the difference between conventional buildings and Green Buildings in terms of features, design and cost.	L4	CO2	5 M
	b)	Explain the different types of Green Building materials commonly used in India and their importance in sustainable construction.	L2	CO1	5 M
		UNIT-II			
4	a)	Analyze the impact of the launch of Green Building rating systems on India's construction industry.	L4	CO2	5 M
	b)	Analyze the benefits experienced in existing Green Buildings in India, focusing on energy savings, water savings, and occupant well-being.	L4	CO3	5 M
		OR			

5	a)	Apply the principles of optimum energy efficiency to propose modifications for an existing old building to make it more sustainable.	L3	CO3	5 M
	b)	Analyze how Green Building opportunities can align with India's climate and Sustainable Development Goals' commitments.	L4	CO3	5 M
		UNIT-III			
6	a)	Apply the principles of Green Building design to suggest modifications for an existing office building to reduce energy demand.	L3	CO3	5 M
	b)	Evaluate the effectiveness of eco-friendly captive power generation systems for medium-scale factories in India.	L5	CO5	5 M
		OR			
7	a)	Compare the energy efficiency outcomes of maximizing system efficiency vs. relying on renewable energy generation.	L4	CO3	5 M
	b)	Critically analyze how onsite sources and sinks, combined with renewable energy use, can help India meet its net-zero carbon goals.	L4	CO5	5 M
		UNIT-IV			
8	a)	Analyze the key design interventions adopted in the CII Godrej Green Business Centre that contribute to its energy efficiency.	L4	CO3	5 M

Code: 23CE2501

Regulation: PVP23

SCHEME for III B.Tech-I Semester – Regular Examinations
November 2025
GREEN BUILDINGS
(Common for ALL Branches)

Duration: 3 hrs **Max marks-70**

PART-A **10X2 = 20M**

1. **a) Define Green Buildings ?**
   Definition – 2 Marks or any similar definition
   b) Mention any two Green Building rating systems applicable in India?
   Mention two rating systems– 2marks
   c) who developed and supported the GRIHA rating system?
   write the names of two Organisation – two marks
   d) Name two typical energy saving approaches for buildings in India
   Any two from the list- 2 marks
   e) Name few passive design strategies and active design systems ?
   Two strategies – 2 marks
   f) What are the types of renewable energy sources ?
   Two sources – two marks
   g) List the critical steps in HVAC Design?
   ANY TWO MAJOR STEPS Give two marks
   h) What are strategies for energy-efficient interior lighting
   Any two stratagies - Two Marks
   i) What are the measures to improve IAQ?
   Any two point - Two Marks
   j) Why certified wood is preferred in green building?
   Any two points – 2marks

PART-B **5x10=50**

UNIT-I

2. **a) Explain why India needs to adopt green buildings in the context of climate change and rapid urbanization**
   Any 5 points – 5 marks

   2 b) Analyze the social, environmental, and economic benefits of Green Buildings with examples
   (any 6 points – 5 marks)

Environmental Benefits: 2 points
Economic Benefits: 2 points
Social Benefits: 2 points
OR

3a) Explain briefly the difference between conventional buildings and Green Buildings in terms of features, design and cost
Any 5 points – 5 marks

3 b) Explain the different types of Green Building materials commonly used in India and their importance in sustainable construction

Any four Green building materials– 4 marks

Importance – 1 mark

UNIT-II

4a) Analyze the impact of the launch of Green Building rating systems on India's Construction industry.

Any 5 points – 5 marks

4 b) Analyze the benefits experience in existing Green Buildings in India, focusing on energy savings, water savings, and occupant well-being

Any 5 points – 5 marks

OR

5a) Apply the principles of optimum energy efficiency to propose modifications for an existing old building to make it more sustainable

Any 5 points – 5 marks

5 b) Analyze how Green Building opportunities can align with India's climate and sustainable development Goals Commitments.

Any 5 points – 5 marks

UNIT-III

6. a) Apply the principles of Green Building design to suggest modifications for an existing office building to reduce energy demand

Any 5 points – 5 marks

6 b) Evaluate the effectiveness of eco-friendly captive power generation systems for medium – scale factories in India

Any 5 points – 5 marks

OR

7a) Compare the energy efficiency outcomes of maximizing system efficiency Vs. relying on renewable energy generation.

Any of the 5 points – 5 marks

7 b) Critically analyze how onsite sources and sinks, combined with renewable energy use, can help India meet its net-zero carbon goals.

Any of the 5 points – 5 marks

UNIT-IV

8. a) Analyze the key design interventions adopted in the CII Godrej Green Business Centre that contribute to its energy efficiency

Any of the 5 points– 5 marks

8 b) Apply energy modeling techniques to evaluate the HVAC system requirements for a commercial building

Any of the 5 points – 5 marks

OR

9 a) Critically analyze the role of cooling towers in optimizing water and energy use in HVAC systems.

Any of the 5 points – 5 marks

9 b) Apply lighting design principles to propose an energy-efficient interior lighting system for a modern office space.

Any of the 5 points – 5 marks

UNIT-V

10. a) Analyze how non process waste handling can be improved at construction sites to minimize environmental impact.

Any of the 5 points – 5 marks

10 b) Evaluate the balance between energy efficiency and IAQ requirements in modern HVAC system design.

Any of the 5 points – 5 marks

OR

11 a) Evaluate various strategies to achieve acceptable IAQ levels in densely populated office spaces

Any of the 5 points – 5 marks

11 b) Evaluate the occupational health risks associated with Sick Building Syndrome.

Any of the 5 points – 5 marks

Code: **23CE2501** **Regulation: PVP23**

SCHEME for III B.Tech-I Semester – Regular Examinations
November 2025
GREEN BUILDINGS
(Common for ALL Branches)

Duration: 3 hrs **Max marks-70**

PART-A

Part-A contains 10 short answer questions. Each question carries 2 Marks 10x2=20M

1. **a) Define Green Buildings ?**
   Ans: Green Building is one that is environmentally responsible and resource-efficient throughout its life cycle—from site selection and design to construction, operation, and demolition. Its aim is to minimize environmental impact while enhancing occupant comfort and health. [or any similar definition]

   b) Mention any two Green Building rating systems applicable in India?
   Ans: 1. IGBC and
   2. GRIHA

   c) who developed and supported the GRIHA rating system?
   Ans: TERI with support from MNRE

   d) Name two typical energy saving approaches for buildings in India
   Ans: Passive Design Strategies: Building Orientation, shading, natural ventilation
   Active Design strategies: Efficient lighting: Use of LED , Reneweble energy, building automation and control, Insulation, Cool roof
   (Any two from the above list)

   e) Name few passive design strategies and active design systems ?
   Ans: Passive strategies use building design features like orientation and shading; active strategies use mechanical systems like HVAC and renewable power.

   f) What are the types of renewable energy sources ?
   Ans: Solar energy, Wind energy, Bio Gas energy, Geothermal Energy

   g) List the critical steps in HVAC Design? *(ANY TWO MAJOR STEPS Give two marks)*

   - Understanding building requirements
   - Load calculations
   - Selection of HVAC system type
   - Air distribution design
   - Ventilation and filtration planning
   - Equipment selection
   - Controls and automation
   - Ducting and piping lay out
   - Testing commissioning and maintenance plan

h) What are strategies for energy-efficient interior lighting

- Use **LED lighting**, task lighting, and efficient fixture placement to reduce power consumption.
- Maximize **daylight utilization** and use lighting controls such as occupancy sensors, timers, and daylight dimmers to avoid energy wastage.

i) What are the measures to improve IAQ? (Any two point from above Two Marks)

Ans:
- Provide fresh air ventilation
- Use low-VOC paints and materials
- Install air filters and purifiers;
- Maintain proper humidity (30–60%) to prevent mold growth
- avoid smoking indoors, store chemicals properly
- Add CO_2/VOC sensors for IAQ monitoring in occupied spaces

j) Why certified wood is preferred in green building?

Ans: Certified wood refers to wood products verified by recognized certification systems to ensure they come from responsibly managed forests.

Using certified wood helps

- conserve forests,
- protect biodiversity,
- prevent illegal logging, and support sustainable construction.

(Any two points from the above)

PART-B

Part-B Contains 5 essay questions with an internal choice form each unit, each question carries 10 marks **5x10=50**

UNIT-I

2. a) Explain why India needs to adopt green buildings in the context of climate change and rapid urbanization (any 5 points – 5 marks)

a. Rapid urbanization is putting heavy pressure on cities, and green buildings help manage sustainable urban growth.
b. Buildings consume a large share of electricity in India, so green buildings reduce energy use and dependence on coal power.
c. Many cities face water shortages; green buildings save water through efficient fixtures, recycling, and rainwater harvesting.
d. Urban air pollution is rising; green buildings provide healthier indoor environments with better ventilation and low-toxicity materials.
e. India's hot and humid climate increases cooling demand; passive design and insulation improve thermal comfort and reduce AC use.
f. Government codes and rating systems (ECBC, GRIHA, IGBC) support the need for green construction.
g. The huge amount of new building construction expected will strain resources unless green practices are adopted.
h. Green buildings offer long-term cost savings through reduced energy and water bills.
i. The sector creates new jobs in green materials, renewable energy, and energy auditing.
j. They help India progress toward national climate commitments and long-term net-zero goals.

2 b) Analyze the social, environmental, and economic benefits of Green Buildings with examples (any 6 points – 5 marks)

Environmental Benefits:

- Reduce energy and water use through efficient systems, lowering pollution and carbon emissions.
- Use of rainwater harvesting, recycling, and native landscaping conserves water and protects ecosystems.
- Adoption of recycled and eco-friendly materials reduces resource depletion and waste generation.

Economic Benefits:

- Lower electricity and water bills due to efficient lighting, HVAC, and plumbing systems.
- Higher property value, faster occupancy, and better market demand for certified green buildings.
- Operational savings and government incentives (tax rebates, extra FAR) make them cost-effective over the life cycle.

Social Benefits:

- Improved indoor air quality, daylight, and low-VOC materials enhance occupant health and comfort.
- Higher productivity and reduced absenteeism in offices due to healthier indoor environments.
- Creation of green jobs in renewable energy, energy auditing, and sustainable construction sectors.

OR

3a) Explain briefly the difference between conventional buildings and Green Buildings in terms of features, design and cost

1. **Conventional buildings** use more electricity, water, and non-renewable materials.
2. **Green buildings** use energy-efficient systems, water-saving fixtures, solar energy, and eco-friendly materials.
3. Green buildings have better indoor air quality, daylight, and ventilation.
4. **Conventional design** focuses mainly on function and cost; little attention to climate or resource efficiency.
5. **Green building design** uses passive design (orientation, shading), insulation, daylighting, and natural ventilation.
6. Green designs include rainwater harvesting, wastewater recycling, and landscape planning.
7. **Conventional buildings** have lower initial cost but higher operating cost due to more energy and water use.
8. **Green buildings** may have slightly higher initial cost but save money in the long run through lower energy and water bills.

3 b) Explain the different types of Green Building materials commonly used in India and their importance in sustainable construction

1. Fly Ash Bricks / Blocks
   - Made from industrial waste (fly ash), replacing clay bricks.
   - Reduce soil erosion, save energy, and offer better strength and insulation.
2. AAC Blocks (Aerated Autoclaved Concrete)
   - Lightweight, good thermal insulation, and reduce dead load.
   - Lower energy needed for cooling and faster construction.
3. Bamboo
   - Fast-growing, renewable material used for flooring, partitions, and structural components.
   - Low carbon footprint and high strength-to-weight ratio.
4. Recycled Steel / Recycled Aluminum
   - Uses less energy during production than new metal.
   - Durable, strong, and reduces mining impact.
5. Low-VOC Paints and Adhesives
   - Reduce indoor air pollution and improve occupant health.
   - Essential for maintaining good indoor air quality.
6. Recycled Wood / Engineered Wood
   - Made from wood waste and agricultural residue.
   - Reduces deforestation and material wastage.
7. Natural Insulation Materials
   - Examples: coconut coir, mineral wool, cellulose.
   - Improve thermal comfort and reduce cooling/heating loads.
8. Cool Roof Materials
   - Reflective coatings or tiles that reduce heat gain.
   - Help reduce indoor temperature and AC energy use.

Importance in Sustainable Construction

- Reduce resource consumption and environmental impact.
- Lower carbon emissions and energy use in buildings.
- Improve indoor comfort and air quality.
- Promote long-term sustainability and cost savings.

UNIT-II

4a) Analyze the impact of the launch of Green Building rating systems on India's Construction industry.

1. Green rating systems (IGBC, GRIHA, LEED) encouraged builders to use **energy-saving and water-saving methods**.
2. Construction companies started using **eco-friendly materials** like fly ash bricks, etc.,
3. More buildings now include **solar panels, rainwater harvesting, and better indoor air quality**.
4. Builders get **benefits from government** such as extra FAR, tax rebates, and fast approvals.
5. Rating systems increased **awareness and training** among architects, engineers, and students.
6. India now has **thousands of green buildings**, making it one of the top countries in green construction.
7. Green buildings help reduce **electricity bills, water use, and pollution**.
8. Companies prefer green-certified buildings for **higher comfort and better working environments**.
9. The movement supports India's **climate goals and net-zero targets**.
10. Overall, green rating systems pushed the industry to build **healthier, efficient, and environmentally friendly buildings**.

4 b) Analyze the benefits experience in existing Green Buildings in India, focusing on energy savings, water savings, and occupant well-being

1. Green buildings in India achieve **20–30% energy savings** through efficient lighting, HVAC, and better building envelopes.
2. Water-saving features like rainwater harvesting and low-flow fixtures provide **up to 50% water reduction**.
3. Improved indoor air quality and ventilation enhance **occupant comfort and health**.
4. Better daylighting increases **productivity and well-being**.
5. Use of low-VOC materials leads to **safer indoor environments**.
6. Green landscapes and vegetation improve **micro-climate and outdoor comfort**.
7. Lower energy and water bills result in **reduced operating costs**.
8. Certified buildings show **higher asset value and occupancy rates**.

OR

5a) Apply the principles of optimum energy efficiency to propose modifications for an existing old building to make it more sustainable

1. Improve building **orientation use** by adding shading devices (overhangs, fins, vegetation) to reduce heat gain.
2. Upgrade the **building envelope** with roof and wall insulation, cool roof coatings, and energy-efficient windows.
3. Increase **daylighting** using skylights, light shelves, and reflective interior surfaces to reduce artificial lighting.
4. Replace old lighting with **LED fixtures** and install sensors (occupancy and daylight) for automatic control.
5. Retrofit HVAC systems with **efficient units**, VRF/VRV systems, and install VFDs on fans and pumps.
6. Improve **natural ventilation** through cross-ventilation, optimized window placement, and ventilated openings.
7. Install **solar PV panels** or solar water heaters to reduce dependence on grid electricity.
8. Use **low-VOC paints** and eco-friendly materials during renovation to enhance indoor quality.
9. Implement **building automation** (BMS) for monitoring and controlling energy use.
10. Conduct regular **energy audits** to track performance and identify further efficiency improvements.

5 b) Analyze how Green Building opportunities can align with India's climate and sustainable development Goals Commitments.

1. Green buildings reduce energy use and carbon emissions, helping India meet its climate commitments.
2. Use of solar PV, solar water heating, and other renewables supports the national clean energy transition.
3. Water-efficient fixtures, rainwater harvesting, and recycling help address India's water scarcity challenges.
4. Sustainable site planning, green roofs, and reduced heat-island effect promote healthier and more climate-resilient cities.

5. Use of recycled, low-carbon, and local materials reduces resource depletion and construction-related pollution.
6. Efficient waste management and recycling practices support responsible material use across the construction sector.
7. Improved indoor air quality and better ventilation enhance occupant health and comfort.
8. Green buildings lower operating costs, supporting long-term economic sustainability.
9. Industry training and adoption of green rating systems promote skilled green jobs and capacity building.
10. Overall, green building opportunities help India shift toward a low-carbon, resource-efficient, and sustainable built environment.

UNIT-III

6. a) Apply the principles of Green Building design to suggest modifications for an existing office building to reduce energy demand

(Any of the 5 points from below – 5 marks) [5 points – 5 Marks]

1. Improve building orientation use by maximizing north light and minimizing east–west heat gain.
2. Add shading devices such as overhangs, fins, louvers, and trees to reduce solar heat.
3. Enhance envelope insulation using insulated roofs, cavity walls, cool roofs, and double-glazed windows.
4. Increase daylight use by optimizing window placement and reducing dependence on artificial lighting.
5. Upgrade to energy-efficient LED lighting, appliances, and HVAC systems.
6. Improve natural ventilation and airflow to reduce cooling load.
7. Install renewable energy systems such as solar photovoltaic panels.
8. Use low-VOC, sustainable materials for interior upgrades to improve indoor quality.
9. Implement rainwater harvesting and low-flow fixtures to reduce water-related energy use.
10. Promote waste reduction, recycling, and proper construction waste management.

6 b) Evaluate the effectiveness of eco-friendly captive power generation systems for medium – scale factories in India

1. Reduce dependency on the grid and cut diesel generator usage.
2. Lower operational cost through renewable sources like solar, wind, and biomass.
3. Provide reliable, continuous power—important for industrial operations.
4. Solar–wind hybrid systems ensure round-the-clock renewable energy supply.
5. Biomass/biogas systems convert waste to energy and reduce disposal burden.
6. Significantly reduce greenhouse gas emissions and air pollution.
7. Support compliance with environmental regulations and green rating requirements.
8. Improve energy self-sufficiency and corporate sustainability performance.

OR

7a) Compare the energy efficiency outcomes of maximizing system efficiency Vs. relying on renewable energy generation. (Any of the 5 points from below – 5 marks)

1. **Maximizing system efficiency** lowers total energy demand through better lighting, HVAC, insulation, and appliances.
2. Efficiency improvements give **immediate and consistent energy savings**, independent of weather conditions.
3. **Renewable energy generation** (solar, wind, biogas) reduces grid dependence and carbon emissions but production varies with climate.
4. Efficient buildings require **smaller renewable systems**, reducing cost and space requirements.
5. Renewables provide clean energy but have **higher initial investment** compared to efficiency upgrades.
6. Best performance is achieved by **first reducing energy demand**, then meeting the remaining load using renewables.

7 b) Critically analyze how onsite sources and sinks, combined with renewable energy use, can help India meet its net-zero carbon goals. (Any of the 5 points from below – 5 marks)

1. Reduce energy demand through passive design, shading, daylighting, and natural ventilation.
2. Improve envelope efficiency using insulation, cool roofs, efficient windows, and air sealing.
3. Lower internal loads with LEDs, efficient HVAC, and BEE-rated appliances.
4. Use onsite renewable sources like solar PV, wind, biogas, and geothermal systems.
5. Add battery storage for reliable, continuous clean power.
6. Convert waste to energy through biogas systems to cut emissions.
7. Reduce HVAC energy using ground-source heat pumps and solar water heaters.
8. Combined demand reduction + onsite renewables helps buildings achieve net-zero carbon.

UNIT-IV

8. a) Analyze the key design interventions adopted in the CII Godrej Green Business Centre that contribute to its energy efficiency(Any of the 5 points from below – 5 marks)

1. India's first **LEED Platinum green building** (2003); headquarters of **IGBC**.
2. Designed to showcase **sustainable construction**, energy efficiency, and green technologies.
3. Climate-responsive site planning with proper orientation, daylighting, and native landscaping.
4. Achieves **50–60% energy savings** using efficient HVAC, LED lighting, high-performance glazing, and solar PV.
5. Strong water efficiency through rainwater harvesting, wastewater treatment, reuse systems, and low-flow fixtures.
6. Uses **local, recycled, and low-VOC materials** with effective waste management practices.

7. Ensures high indoor environmental quality with natural ventilation, CO_2 monitoring, and eco-friendly interiors.
8. Integrates renewable energy systems—solar PV, solar hot water, and green roof features.
9. Serves as a **training, research, and demonstration center** for green building practices.
10. Achieves **30–40% water savings**, reduced operating costs, and inspires green buildings across India.

8 b) Apply energy modeling techniques to evaluate the HVAC system requirements for a commercial building (Any of the 5 points from below – 5 marks)

1. Identifies design changes that reduce cooling load and HVAC energy consumption.
2. Optimizes building orientation to minimize heat gain.
3. Improves daylighting to lower internal heat and lighting load.
4. Enhances thermal comfort through better insulation and glazing.
5. Ensures accurate HVAC sizing and avoids over/under-sizing.
6. Improves envelope performance by selecting efficient walls, roofs, and shading.
7. Assesses solar PV potential to offset HVAC energy use.
8. Reduces overall cost through optimized energy-efficient design choices.

OR

9 a) Critically analyze the role of cooling towers in optimizing water and energy use in HVAC systems. (Any of the 5 points from below – 5 marks)

1. Proper sizing ensures efficient heat rejection and reduces chiller energy use.
2. Efficient tower types (induced draft, counter-flow/cross-flow) improve cooling performance and save energy.
3. Lower approach temperature enhances tower efficiency and reduces chiller load.
4. Selection based on local wet-bulb temperature improves year-round performance.
5. Low-drift design minimizes water loss and saves make-up water.
6. Energy-efficient fans and VFDs reduce power consumption at part load.
7. High-performance fill, nozzles, and corrosion-resistant materials improve heat transfer and water efficiency.
8. Proper water treatment prevents scaling and fouling, maintaining thermal efficiency.
9. Adequate space, airflow, and noise control support optimal operation and maintenance.
10. Meets ECBC/IGBC low kW/TR requirements, ensuring overall HVAC energy efficiency.

9 b) Apply lighting design principles to propose an energy-efficient interior lighting system for a modern office space. (Any of the 5 points from below – 5 marks)

1. Provide required lux levels with balanced task and ambient lighting.
2. Use LED fixtures with high lumens/Watt and proper beam angles.
3. Integrate daylight through windows, skylights, and light shelves while avoiding glare.
4. Ensure uniform light distribution using proper layout and reflective interior surfaces.
5. Use lighting controls—occupancy sensors, daylight sensors, and zonal switching.
6. Apply task lighting to illuminate only work areas and reduce overall load.
7. Optimize fixture placement with efficient optics and correct mounting heights.
8. Maintain low Lighting Power Density (LPD) as per ECBC/IGBC norms.
9. Maximize daylight utilization to cut artificial lighting demand.
10. Ensure regular maintenance for maximum lighting efficiency.

UNIT-V

10. a) Analyze how non process waste handling can be improved at construction sites to minimize environmental impact. (Any of the 5 points from below – 5 marks)

- Non-process waste refers to waste generated from building activities and daily operations that is not part of the main industrial or production process.
- Examples include paper, plastic, cardboard, glass, metal cans, food waste, packaging waste, garden waste, and e-waste.
- Effective management helps reduce landfill disposal, pollution, and resource consumption, and is a key criterion in IGBC, GRIHA, and LEED ratings.
- Segregate waste at source using color-coded bins.

1. Follow Reduce–Reuse–Recycle principles to minimize waste.
2. Manage organic waste through composting or biogas.
3. Dispose e-waste safely through authorized recyclers.
4. Segregate and recycle C&D waste as per green building guidelines.
5. Provide safe storage areas to prevent mixing of hazardous and recyclable waste.
6. Tie up with certified vendors for recycling and timely disposal.
7. Conduct awareness and training programs on proper waste handling.
8. Adopt green procurement to reduce waste generation.
9. Maintain records and conduct periodic waste audits.

10 b) Evaluate the balance between energy efficiency and IAQ requirements in modern HVAC system design. (Any of the 5 points from below – 5 marks)

1. Adequate fresh air improves IAQ but increases energy load.
2. High-efficiency filters improve IAQ but require more fan energy.
3. Humidity control (30–60%) maintains IAQ but consumes energy.
4. DOAS, HRV/ERV systems recover energy while supplying fresh air.
5. Demand-controlled ventilation (DCV) optimizes IAQ only when needed.
6. Low-VOC materials reduce ventilation demand and save energy.
7. Regular HVAC maintenance improves IAQ and reduces energy use.
8. IAQ sensors and smart controls balance ventilation and energy efficiency.

OR

11 a) Evaluate various strategies to achieve acceptable IAQ levels in densely populated office spaces (Any of the 5 points from below – 5 marks)

1. Provide adequate fresh air as per ASHRAE/ISHRAE ventilation standards.
2. Ensure efficient HVAC design with clean filters, ducts, and coils; maintain humidity at 30–60%.
3. Use high-efficiency filtration (MERV/HEPA) to remove PM2.5, PM10, pollen, and dust.
4. Use low-VOC paints, adhesives, furniture; avoid toxic materials.
5. Control pollutant sources with separate exhausts and strict no-smoking policies.

6. Install CO_2, VOC, and PM sensors for continuous IAQ monitoring.
7. Prevent moisture and mold through proper drainage, insulation, and leak control.
8. Incorporate green interiors and indoor plants for supportive air improvement.
9. Follow proper construction practices and housekeeping to reduce dust and contaminants.
10. Provide training and awareness to staff on ventilation and IAQ best practices.

11 b) Evaluate the occupational health risks associated with Sick Building Syndrome.

- A condition where building occupants experience health issues due to poor IAQ, which subside upon leaving the building.
- Inadequate ventilation and use of low-quality interior finishes emitting VOCs.

Occupational Health Risks of Sick Building Syndrome (SBS)

1. Reduced productivity and poor work performance.
2. Respiratory problems and allergic reactions.
3. Eye and skin irritation.
4. Increased sick leave and absenteeism.
5. Potential long-term respiratory and health issues.

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