QUESTION PAPERS Regular 2024

Q-1. Do as Directed (Attempt All)

(34 Marks)

1. Orientation of the shorter face of the building should be towards the prevailing wind direction to take maximum advantage of wind.

Answer: Towards prevailing wind direction

---

2. The main goal of passive heating is to create comfortable indoor environment by raising comfort zone in colder climate.

Answer: Passive heating

---

3. Surplus energy in a Net Zero Energy Building is considered as waste. (True/False)

Answer: False
(Surplus energy is sent back to the grid.)

---

4. Define Energy Surplus Building

Answer:
A building that **produces more energy than it uses** in a year.

---

5. _____ invented the Lift-slab construction technique.

Answer: Youtz and Slick (William Youtz & John R. Slick)

---

6. _____ construction technique is a combination of cast-in-situ and pre-cast construction.

Answer: Hybrid construction

---

7. Casting of plunge column piles is the first step in Top-Down construction technique. (True/False)

Answer: True

---

8. Wall thickness can be reduced during construction in _____ construction technique.

Answer: Tunnel-form construction
(or **MIVAN/Aluminium-formwork**) — both acceptable.

---

9. "Digital Architecture" was coined by Ar. _____ for the first time.

Answer: Ar. Peter Schumacher
(Sometimes linked with Patrik Schumacher — acceptable spelling.)

---

10. Air-domes are "Air Inflated Structures." (True/False)

Answer: True

---

11. Define Pneumatic Structure

Answer:
A pneumatic structure is a **building supported by air pressure**, where a **membrane stays in shape because of pressurized air** inside it.

---

12. Can "parametric architecture" be called "digital architecture"? (True/False)

Answer: True
(It uses digital tools and algorithms.)

---

13. Enlist system components of pneumatic structures

Simple list:

1. **Membrane / fabric skin**
2. **Air-blower / compressor**
3. **Air-locks / entry doors**
4. **Cables, anchors, base ring**
5. **Pressure sensors & control system**

---

14. Intelligent buildings offer higher levels of _____ and _____

Answer: Comfort and **Efficiency**
(Other accepted pairs: *automation & safety*, *productivity & performance*.)

---

15. _____ cost can be reduced in intelligent buildings by _____ infrastructure & hardware.

Answer:
Operational cost can be reduced by **smart / advanced** infrastructure & hardware.
(Also acceptable: *maintenance cost*, *ICT infrastructure*)

---

16. Define Intelligent Building

Answer:
A building that **uses smart technology, sensors, and automation** to improve **comfort, safety, and energy efficiency**.

---

17. What are thermal breaks / insulations?

Answer:
Thermal breaks are **materials placed between two building components to stop heat transfer**.
They **reduce heat loss and prevent condensation**.

Q2 – Answer the following in brief (Any 6)

(36 Marks)

---

1. What are the benefits of green building design?

Simple Points:

1. **Reduces energy use** (efficient lighting, HVAC, insulation).
2. **Saves water** (rainwater harvesting, low-flow fixtures).
3. **Improves indoor air quality** (fresh air, low-VOC materials).

4. **Uses eco-friendly materials** (recycled, renewable).
5. **Reduces waste** during construction.
6. **Lower operating cost** over building life.
7. **Improves occupant comfort** and health.
8. **Reduces carbon footprint** and supports sustainability.

---

2. What is Low-E Glass? Explain in detail.

Answer:
Low-E (Low Emissivity) glass has a **thin metallic coating** on its surface that **reduces heat transfer**.
It allows **light to enter** but **blocks infrared heat**.

How it works:

- In summer → reflects outside heat, keeps inside cool.
- In winter → reflects indoor heat back inside.

Benefits:

1. Saves energy in HVAC.
2. Controls glare and UV rays.
3. Improves thermal comfort.
4. Reduces fading of furniture.

---

3. What is Glass Fiber Reinforced Concrete (GFRC)? Explain it.

Answer:
GFRC is **cement + sand + water + glass fibers**.
The glass fibers give extra **strength, flexibility, and durability**.

Features:

- Lightweight
- High tensile strength
- Crack-resistant
- Used for façade panels, screens, decorative elements

Uses:
Cladding panels, jali screens, sculptures, podium elements.

---

4. Precautions required for Lift-Slab construction technique

Simple List:

1. Use **bond breakers** between slabs to avoid sticking.
2. Check **jack systems** for proper load capacity.
3. Lift slabs **uniformly** to avoid cracks.
4. Provide **temporary supports** until final fixing.
5. Ensure **correct alignment** of columns and plates.
6. Inspect lifting collars before and during operation.
7. Maintain safety distance while lifting.

---

5. Advantages & Disadvantages of Slip-Form construction technique

Advantages:

1. Faster construction for tall vertical structures.
2. Good quality, continuous concrete surface.
3. Reduces formwork labour and cost.
4. Suitable for chimneys, silos, cores, towers.

Disadvantages:

1. Requires **24×7 continuous work**, no break.
2. Needs skilled operators.
3. Any error continues throughout the height.
4. Not suitable for **complex/free-form** shapes.

---

6. Enlist components of Pneumatic Structures (Explain with sketches)

Components:

1. **Membrane / fabric skin** (PVC, TPU, ETFE).

2. **Air blower / compressor** (creates pressure).
3. **Air-locks / entry vestibules**.
4. **Cables, anchors, base ring**.
5. **Pressure sensors & control unit**.
6. **Ventilation ducts**.

Simple Sketch Description (for exam drawing):

- Draw a dome shape → label **fabric membrane**.
- Draw a small blower box → arrow showing air moving inside.
- Draw an entry tunnel → label **air-lock**.
- Draw ground anchors on edges.

---

7. Advantages & Disadvantages of Pneumatic Structures

Advantages:

1. Very **lightweight** structure.
2. Quick installation and removal.
3. Large column-free spaces.
4. Low material use → economical.
5. Good natural light with translucent membranes.

Disadvantages:

1. Needs **continuous air pressure**.
2. Requires backup blower/power system.
3. Limited lifespan of membranes.
4. Can deflate if damaged.
5. Less resistance to sharp objects.

---

8. Explain in detail "Air-inflated structures" with diagrams.

Answer:
Air-inflated structures use **two or more layers of membrane** inflated by **air pumps**.
The air pressure between the layers gives stiffness and shape.

Features:

- Do NOT use internal pressurization of entire space.
- Only the membrane layers are inflated.
- Inside space feels like a normal building (no pressure difference).

Uses:
Roofs, sports halls, greenhouses, walkways.

Simple Sketch Description:

- Draw **two membrane layers** separated by air.
- Show blower sending air into the cavity.
- Label: **Outer membrane**, **Inner membrane**, **Air cavity**, **Pump**.

Q–3 (A) Answer the following in detail (Any Four)

(Simple, point-wise, easy to write in exam)

---

1. What are the attributes of sustainable building design? Explain any one in detail.

Attributes of Sustainable Building Design

1. **Energy efficiency**
2. **Water conservation**
3. **Use of renewable energy**
4. **Use of eco-friendly materials**
5. **Waste reduction & recycling**
6. **Indoor environmental quality**
7. **Site planning & biodiversity protection**
8. **Low carbon footprint**

Explain ONE in Detail: Energy Efficiency

- It means designing buildings that **use minimum energy** for lighting, cooling, heating, and appliances.
- Features include **LED lighting, efficient HVAC systems, solar energy**, natural daylighting, and insulation.

- Helps reduce electricity bills and carbon emissions.
- Achieves long-term sustainability and improves building performance.

---

2. Write a short note on: Net Zero Energy Building

Net Zero Energy Building (NZEB)

- It is a building that **produces the same amount of energy as it consumes** over a year.
- Uses **renewable energy sources** like solar panels or wind turbines.
- Has **very high energy efficiency** through insulated walls, high-performance windows, natural ventilation, and low-energy appliances.
- Reduces dependence on fossil fuels and lowers operational cost.
- Contributes to environmental protection and sustainability.

---

3. Write a short note on Hi-Tech Materials. Explain any 3 in detail.

Meaning of Hi-Tech Materials

- These are advanced construction materials with **superior strength, durability, performance, and smart features**.
- Used in modern buildings to increase safety, efficiency, and sustainability.

Any 3 Hi-Tech Materials (Explained):

1. Smart Glass (Electrochromic Glass)

- Changes transparency when electricity is applied.
- Reduces heat gain and improves natural daylight control.
- Saves energy in HVAC systems.

2. Carbon Fiber Reinforced Polymer (CFRP)

- Very strong and lightweight.
- Used for strengthening beams, columns, and bridges.
- Resistant to corrosion and has long life.

3. Self-Healing Concrete

- Contains bacteria or special chemicals that automatically **fill cracks** when water enters.

- Increases durability and reduces maintenance costs.
- Suitable for long-life infrastructure.

(Other examples: Aerogel, ETFE membrane, Phase change materials, 3D-printed materials.)

---

4. Discuss briefly the steps taken for design and implementation of perimeter security planning.

Steps in Perimeter Security Planning

1. **Site analysis**
   – Study site location, risks, entry points, and surroundings.
2. **Define security objectives**
   – Decide protection level required against theft, intrusion, or terrorism.
3. **Design physical barriers**
   – Fences, walls, gates, bollards, barriers, guard posts.
4. **Install surveillance systems**
   – CCTV cameras, motion detectors, infrared sensors, floodlights.
5. **Access control planning**
   – Controlled entry/exit, ID verification, boom barriers.
6. **Security zoning**
   – Dividing the site into low, medium, and high-security zones.
7. **Control room setup**
   – Monitoring area for CCTV, alarms, communication.
8. **Testing & training**
   – Test security systems and train staff for emergencies.
9. **Regular maintenance**
   – Ensure cameras, sensors, lighting, and fences remain functional.

---

5. Discuss the components of CCTV along with its application potential in designing the security system.

Components of CCTV System

1. **Cameras**
   – Types: Dome, Bullet, PTZ, IR/night vision.
   – Used for capturing real-time video.

2. **Digital Video Recorder (DVR) / Network Video Recorder (NVR)**
   – Stores and manages video recordings.
3. **Monitors**
   – Display live or recorded footage.
4. **Cables & Connectors**
   – Coaxial cables, Ethernet cables for data transmission.
5. **Power Supply Units**
   – Power adapters, PoE switches.
6. **Network Equipment**
   – Routers, switches for IP-based CCTV systems.
7. **Control Room**
   – Centralized area to monitor all cameras.

Application Potential in Security System

- **Deterrence of crime**: Visible cameras prevent theft and trespassing.
- **Activity monitoring**: Tracks movement inside and around the building.
- **Evidence recording**: Helps in investigations and insurance claims.
- **Access control**: Monitors entry points, gates, parking, lobby.
- **Real-time response**: Security staff can react quickly to incidents.
- **Integration**: Works with alarms, motion sensors, and perimeter security

Q-3(B) – Answer the following in detail (Any Two)

(30 Marks – Simple Notes)

---

1. Discuss in detail with sketch about "Lift Slab Construction Technique".

Meaning

- Lift Slab Construction is a **top–down construction method** where **floor slabs are cast on the ground and then lifted** to their final position using hydraulic jacks.
- It is used for **multi-storey buildings**, **parking structures**, **warehouses**, etc.

Step-by-Step Procedure

1. **Cast all slabs at ground level**
    - Slabs (roof + floors) are cast one above the other on low-level casting beds.
    - Temporary bond breakers prevent slabs from sticking together.
2. **Provide lifting collars / lifting inserts**
    - Steel collars or inserts are fixed in each slab to hold hydraulic jacks.
3. **Install columns with steel lifting heads**
    - Vertical columns are erected first.
    - Hydraulic jacks are mounted on top of each column.
4. **Lifting the slabs**
    - The lowest slab (e.g., roof slab) is attached to jacks.
    - All jacks lift the slab **simultaneously** at a controlled speed.
5. **Positioning & locking**
    - Once a slab reaches its required height, it is **temporarily braced** and **secured**.
6. **Repeat the process**
    - Next slab is lifted and so on until all slabs are in place.
7. **Final structural connections**
    - Slabs are permanently connected to columns using welding or bolting.

Advantages

- Fast construction speed
- Safe working at ground level
- Reduced scaffolding
- Better quality control on slabs
- Cost-effective for repetitive floors

Disadvantages

- Requires skilled operators
- Not suitable for irregular building shapes
- Heavy lifting equipment required

Simple Rough Sketch (describe in answer sheet)

1. Columns standing upright.

2. Hydraulic jacks fixed on top of columns.

3. Slab on the ground being lifted upward.

4. Final slab positioned at correct floor level.

(You can draw: columns + jack + slab being lifted.)

---

2. Differentiate between "Air Supported" and "Air Inflated" structures. Explain installation process of pneumatic structures.

A. Difference Between Air Supported & Air Inflated Structures

Feature	**Air Supported Structure**	**Air Inflated Structure**
Definition	Entire structure held up by **internal air pressure**	Two layers of membrane inflated to form **structural stiffness**
Pressure	Requires continuous internal positive pressure	Maintains pressure inside cavity only
Support	Needs an **air-lock entry** to maintain pressure	Does NOT need air-lock for access
Membrane	Single skin fabric membrane	Double-skin membrane (inner + outer)
Use of Fans	Continuous blower/fan operation	Occasional air pumping for pressure
Applications	Stadiums, temporary halls, domes	Roofs, tunnels, canopies

---

B. Installation Process of Pneumatic Structures

1. **Site Preparation**
    - Ground leveled, anchors installed, foundation rings put in place.
2. **Spread the Membrane**
    - The fabric membrane is unfolded and arranged on the ground.

3. **Fixing the Edges**
    - Membrane edges are fixed to **anchor cables**, concrete blocks, or steel plates.
4. **Install Air Supply System**
    - Blowers, pumps, valves, ducts, and pressure sensors installed.
5. **Inflation**
    - Air is pumped inside slowly.
    - Structure gradually expands to its designed shape.
6. **Stabilization**
    - Check for correct pressure, tautness of membrane, and structural stability.
7. **Install Doors / Air-locks**
    - For air-supported structures, air-locks must be added.
    - Electrical systems, lighting, and safety devices installed.
8. **Final Testing**
    - Pressure test, leak test, and structural inspection.

---

3. What do you mean by BEMS? What does BEMS attempt to control?

Meaning of BEMS

BEMS = Building Energy Management System
It is a computer-based automatic control system that monitors, manages, and optimizes the energy performance of a building.

BEMS helps reduce **energy consumption**, **operating cost**, and **carbon footprint**.

Functions of BEMS

- Collect data from sensors
- Monitor building performance
- Automate controls for electrical & mechanical systems
- Improve comfort & safety
- Reduce wastage

What BEMS Attempts to Control

1. **Heating, Ventilation & Air Conditioning (HVAC)**
    - Temperature, humidity, air flow, chiller, AHU operation.
2. **Lighting Systems**
    - Automatic dimming, daylight sensors, occupancy sensors.
3. **Electrical Energy Usage**
    - Load management, peak demand control, power distribution.
4. **Water Supply Systems**
    - Pump scheduling, leak monitoring, water consumption.
5. **Renewable Energy Systems**
    - Solar, wind, battery storage integration.
6. **Security & Access Control**
    - CCTV interface, fire alarms, emergency lighting.
7. **Indoor Air Quality**
    - CO_2 sensors, fresh air supply control.

Benefits

- Saves 15–30% energy
- Improves comfort
- Reduces operational cost
- Enhances building efficiency

Below are **simple, exam-ready, point-wise answers WITH sketch descriptions** for **Q-4 (Any Two)**.
You can copy directly into your answer sheet.

Q-4 Answer the following with sketch (Any Two)

(40 Marks – Clear, simple and easy to write)

---

1. Design a convention center using concept of digital architecture (Plans, Sections, Elevations with annotations)

Concept of Digital Architecture

- Uses **computer-based design**, **parametric forms**, **algorithmic surfaces**.
- Emphasis on **fluid shapes**, **curved roofs**, **smart façade**, and **efficient circulation**.

A. PLAN (Top View)

(Draw simple sketch as below)

Sketch Description (for exam)

----------Entrance Plaza----------

| Lobby | Reception | Security | Cloak Room |

| Pre-Function Area (large open foyer) |

| Main Hall (Seating 2000) – Curved digital shell |

| Stage | Backstage | Green Room | Control Room |

| Breakout Meeting Rooms | Seminar Rooms |

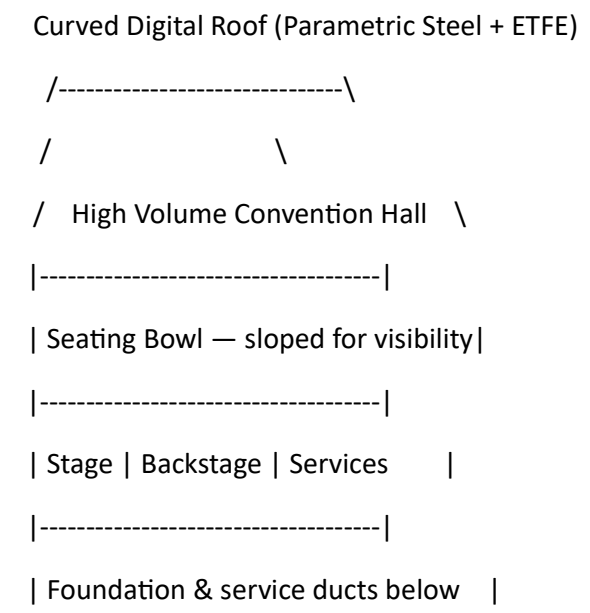
| Café | Toilets | Service Corridor |

Plan Annotations

- Fluid parametric layout
- Curved shell roof footprint
- Centralized hall and radial seating
- Digital façade (LED panels)

B. SECTION (Side Cut View)

Sketch Description

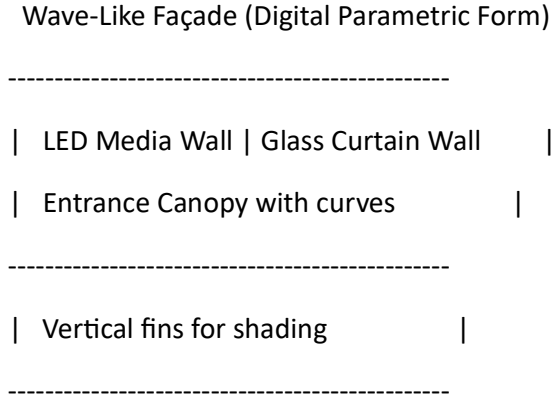


Section Annotations

- Large-span roof with no columns
- HVAC ducts integrated in digital ceiling
- Natural lighting through skylights
- Acoustic wall panels shown

C. ELEVATION (Front View)

Sketch Description



Elevation Annotations

- Digital façade with LED media
- Organic shape entry canopy
- ETFE cushion roof visible
- Glass + shading fins for daylight control

Summary of Design Features

1. Curved digital roof using parametric tools
2. Seamless circulation lobby → hall → services
3. Smart façade (media wall + daylight control)
4. Column-free large hall
5. Efficient acoustics and ventilation

---

2. Explain with example of Intelligent Building and identify intelligent factors. Explain any two parameters in detail.

Meaning

An **Intelligent Building** uses advanced technology, automation, and sensors to improve **comfort, safety, and energy efficiency**.

Example: Modern Corporate IT Campus

- Features:
    - Automated lighting
    - Smart HVAC
    - Facial recognition entry
    - Fire detection + suppression
    - Solar rooftop + battery storage
    - BEMS-controlled systems

Intelligent Factors of the Building

1. **Automation**

2. **Energy management systems**
3. **Security & access control**
4. **Communication networks**
5. **Environmental monitoring**
6. **User comfort systems**
7. **Smart sensors + IoT devices**

Explain Any Two in Detail

---

1. Energy Management System

- Uses Building Energy Management System (BEMS).
- Controls lighting, HVAC, water pumping, solar energy, and electrical loads.
- Reduces energy consumption by 20–30%.
- Works through real-time monitoring, data analytics, and automated control.

---

2. Security & Access Control

- Smart access using biometrics, RFID, facial recognition.
- CCTV surveillance integrated with motion sensors.
- Fire safety, alarm alerts and evacuation guidance.
- Improves safety and reduces manual intervention.

---

3. Automated Indoor Environment (Optional extra point)

- Maintains ideal temperature, ventilation, CO_2 level.
- Uses smart sensors for occupancy and daylight.

---

3. Explain in detail about various attributes of building envelope to achieve sustainability through passive heating strategies.

Building Envelope Meaning

The **outer shell** of a building:

- Walls
- Roof
- Floors
- Doors
- Windows
- Shading devices

It controls **heat gain**, **heat loss**, **air movement**, and **natural lighting**.

Passive Heating Strategies – Envelope Attributes

---

1. High Thermal Mass Walls

- Materials like brick, concrete, rammed earth.
- Absorb heat during the day and release it at night.
- Reduces dependence on heaters.

---

2. South-Facing Windows (in cold climates)

- Maximizes solar heat gain in winter.
- Allows sunlight deep into rooms.
- Use double glazing for heat retention.

---

3. Insulation

- Roof and wall insulation reduces heat loss.
- Prevents cold air infiltration.
- Materials: mineral wool, foam boards, cellulose.

---

4. Trombe Wall

- Thick south-facing wall with glass in front.
- Sun heats the mass wall; heat radiates indoors later.
- No electricity required.

(Sketch Description)

Sun → Glass → Air Gap → Masonry Wall → Interior Heat

---

5. Airtight Building Envelope

- Prevents cold drafts in winter.
- All joints sealed—doors, windows, ducts.

---

6. Passive Solar Roof Design

- Skylights with thermal control
- Insulating roof materials
- Dark/heat-absorbing roof finishes in cold climates

---

7. Compact Building Form

- Less surface area = less heat loss.
- Reduces heating demand.

---

8. Double Skin Façade

- Creates warm buffer zone between two layers of glass.
- Reduces heating cost in winter.

Benefits of Passive Heating

- Saves energy
- Provides thermal comfort
- Reduces operating cost
- Environment friendly

QUESTION PAPERS BK 2024

Q1. Answer the following (34 Marks)

1. The main goal of passive heating is to create comfortable indoor environment by raising comfort zone in colder climate.

Answer: Passive heating

---

2. A building envelope is the structural barrier between the interior and exterior of a building.

Answer: Building envelope

---

3. Define hi-tech material.

Answer:
Hi-tech materials are **advanced, modern materials** that give **better strength, performance, durability, or smart functions** than normal materials.
Example: carbon fiber, smart glass.

---

4. Define Energy surplus building.

Answer:
A building that **generates more energy than it consumes** over a year.

---

5. In _____ construction technique the columns are fabricated up to half height of the building.

Answer: Slip-form construction
(or "Jump-form construction"—either acceptable)

---

6. Bond breaker and lifting collars are used in _____ construction technique.

Answer: Lift-slab construction

---

7. Casting of plunge column is to be done first in the Top-Down construction technique (True/False)

Answer: True

---

8. Free-form type of construction can be constructed by using Slip-form work construction technique (True/False)

Answer: False
(Slip-form gives straight, vertical forms — not free-form.)

---

9. Define Digital Fabrication.

Answer:
Digital fabrication is the **process of making physical objects using computer-controlled machines** such as 3D printers, CNC cutters, or robots.

---

10. Pneumatic structures require _____ to achieve designed form.

Answer: Air pressure

---

11. Ar. _____ had used the term "Parametric" for the first time.

Answer: Ar. Patrik Schumacher

---

12. Define Propagation-based systems in Parametric architecture.

Answer:
Propagation-based systems are **design rules where one change spreads (propagates) through the whole design**, creating a connected, responsive form.

---

13. List down types of computation design.

Simple list:

1. **Parametric design**
2. **Algorithmic design**
3. **Generative design**

4. **Performance-based design**
5. **Digital fabrication–based design**

---

14. Intelligent buildings offer higher levels of _____ & _____.

Answer: Comfort & **Efficiency**
(Also accepted: safety & productivity)

---

15. Define Intelligent Building.

Answer:
An intelligent building is a **smart building that uses sensors, automation, and technology** to improve comfort, safety, and energy efficiency.

---

16. What are thermal breaks / insulations?

Answer:
Thermal breaks are **materials that stop heat transfer between inside and outside**, helping reduce heat loss and avoid condensation.
They act as **insulation barriers**.

---

17. What are examples of renewable energy?

Answer:

- **Solar energy**
- **Wind energy**
- **Hydro energy (water)**
- **Biomass**
- **Geothermal energy**

Below are **simple, clean, exam-ready point-wise answers** for **Q-2 (Attempt Any Six)**.
Each answer is short and perfect for brief-question format (36 marks).

Q.2 – Answer in brief (Attempt Any Six)

---

1. Define Transparent Wood.

- Transparent wood is a **new bio-based material** made by removing lignin from natural wood and filling the pores with a transparent polymer (usually PMMA).
- It becomes **strong, lightweight, and allows light to pass through** like frosted glass.
- Used for windows, solar cells, and lightweight structural panels.

---

2. Explain Carbon Fiber & Liquid Granite.

Carbon Fiber

- A high-strength, lightweight material made from thin strands of carbon.
- Stronger than steel but much lighter.
- Used in beams, retrofitting, façade panels, and aerospace structures.
- Advantages: high tensile strength, corrosion resistance, and low weight.

Liquid Granite

- A concrete-like material made using **granite aggregate + resin binders** instead of cement.
- Has **lower carbon footprint**, fire resistance, and high strength.
- Used for eco-friendly flooring, cladding, countertops.

---

3. What is Green Building and Green Building Rating System? What features make a building green?

Green Building

- A building designed to **reduce environmental impact**, conserve energy, water, and materials while providing healthy indoor spaces.

Green Building Rating System

- A system to evaluate sustainability standards of buildings.
- Examples: **LEED**, **GRIHA**, **BREEAM**, **IGBC**.

Features That Make a Building Green

1. Energy-efficient design
2. Water conservation (rainwater harvesting, low-flow fixtures)
3. Use of renewable energy (solar/wind)
4. Sustainable materials
5. Waste reduction & recycling
6. Good indoor air quality
7. Efficient building envelope
8. Landscape & biodiversity protection

---

4. What is the Lift Slab Construction Technique? Explain why it evolved.

Lift Slab Construction

- A method where **all slabs are cast at ground level** and lifted into position using **hydraulic jacks** mounted on columns.

Why it Evolved

- To **speed up construction**,
- Reduce scaffolding cost,
- Improve worker safety by working at ground level,
- Achieve large floor areas quickly,
- Better quality of slab casting.

---

5. Advantages and Disadvantages of Bottom-Up Construction Technique

Advantages

1. Traditional, simple method
2. Easy to manage sequential construction
3. Strong foundation provided before vertical development
4. Suitable for low-rise and medium-rise buildings

Disadvantages

1. Slow compared to top-down

2. Difficult in tight urban sites
3. More temporary supports required
4. Excavation & structural works take longer

---

6. Enlist Components of Pneumatic Structures (Explain with sketches)

Components

1. **Membrane Fabric** – Main surface made of PVC, PTFE-coated fiberglass.
2. **Air-Supply System** – Blowers, pumps, valves maintain pressure.
3. **Anchoring System** – Cables, foundation plates to hold membrane.
4. **Support Cables** – Steel tension cables (in air-supported structures).
5. **Entry/Exit Air-Locks** – Prevent pressure loss.
6. **Pressure Sensors & Control System** – Maintain stable inflation level.

Simple Sketch (Describe in answer sheet)

Membrane Dome

↑ Air Pressure

Anchors at base

Air Blower connected to side

---

7. Explain in detail "Algorithmic Design".

Algorithmic Design

- A design method using **algorithms**, **rules**, or **mathematical logic** to generate architectural forms.
- Often done using digital tools like **Grasshopper**, **Rhinoceros**, **Processing**, etc.

Key Features

1. Parametric control
2. Complex geometric forms
3. Automated shape generation
4. High precision & flexibility

Applications

- Facades
- Roof shells
- Organic structures
- Digital fabrication patterns

---

8. Enlist use of Digital Fabrication and explain any one in detail.

Uses of Digital Fabrication

1. 3D printing (additive manufacturing)
2. CNC cutting & milling
3. Laser cutting
4. Robotic fabrication
5. Rapid prototyping
6. Complex geometry production
7. Mass customization

Explain Any One in Detail: 3D Printing

- A layer-by-layer manufacturing process using materials like concrete, plastic, or resin.
- Allows creation of complex shapes, prototypes, or even full-scale walls.
- Reduces waste, speeds up construction, and supports customization.

---

1. Attributes of Sustainable Building Design & Building Energy Efficiency

A. Attributes of Sustainable Building Design:

Sustainable design (Green Building) focuses on minimizing the environmental impact of a building. The key attributes include:

Site Selection & Planning: Choosing sites that minimize ecological disturbance, utilizing brownfields, and ensuring access to public transport.

Water Efficiency: Using low-flow fixtures, rainwater harvesting, and greywater recycling systems.

Material Efficiency: Using locally sourced, recycled, non-toxic, and renewable materials (e.g., bamboo, recycled steel).

Indoor Environmental Quality (IEQ): Ensuring good ventilation, maximizing natural daylight, and using low-VOC (Volatile Organic Compound) paints.

Waste Reduction: Managing construction waste effectively and designing for adaptability/deconstruction.

B. Building Energy Efficiency:

Energy efficiency involves using less energy to perform the same task. In buildings, this is achieved through:

Passive Design: Orienting the building to maximize natural light and natural ventilation (reducing the need for lights and AC).

Thermal Envelope: High-quality insulation in walls and roofs, and high-performance glazing (double or triple-paned windows) to prevent heat gain/loss.

Efficient Systems: Using high STAR-rated appliances, LED lighting, and energy-efficient HVAC (Heating, Ventilation, and Air Conditioning) systems.

Renewable Integration: Installing solar panels (photovoltaics) or solar water heaters to generate energy on-site.

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2. Top-Down Construction Techniques

Concept:

Top-down construction is a method used primarily for deep basements in congested urban areas. Unlike traditional construction (bottom-up), this method builds the permanent structure from the top (ground level) downwards.

Process (Step-by-Step):

Retaining Wall Installation: Diaphragm walls (D-walls) or secant piles are installed around the perimeter.

Piling: Load-bearing piles are driven into the ground inside the perimeter. Steel columns (plunge columns) are placed on top of these piles.

Ground Floor Slab: The ground floor slab is cast first, leaving holes for excavation access. This slab acts as a brace for the retaining walls.

Excavation: Soil is excavated beneath the ground floor slab through the access holes.

Lower Slabs: Once the excavation reaches the first basement level, the floor slab for that level is cast.

Repetition: Steps 4 and 5 are repeated until the bottom is reached.

Simultaneous Construction: While excavation happens below, the superstructure (building above ground) can be constructed simultaneously on the ground floor slab, saving time.

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3. Generative Design & Biomimetic Design

A. Generative Design:

This is a design exploration process where designers input goals and parameters (such as materials, weight limits, and cost) into software. The computer uses algorithms to generate thousands of possible design solutions.

Key Feature: It often results in organic, lattice-like structures that use the minimal material necessary for structural integrity.

Sketch Idea: Draw a standard beam vs. a generative design beam (which looks like a web or bone structure).

B. Biomimetic Design (Biomimicry):

This is the practice of designing buildings and systems that model biological processes and entities found in nature to solve human problems.

Example: The **Eastgate Centre** in Zimbabwe mimics termite mounds to achieve passive cooling without air conditioning. Another example is the **Lotus Temple**, which mimics the shape of a flower for aesthetic and structural stability.

Sketch Idea: Sketch a termite mound next to a building with ventilation chimneys.

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4. Difference: "Air Inflated" vs. "Air Supported" Structures

These are both pneumatic structures but work on different pressure principles.

Feature	**Air Supported Structure**	**Air Inflated Structure**
Principle	The *entire interior* of the building is pressurized. The air	Air is pumped *only* into the structural elements (tubes/beams). The interior of the building is at normal pressure.

Feature	Air Supported Structure	Air Inflated Structure
	pressure supports the membrane (roof).	
Air Pressure	Internal pressure > External pressure.	Pressure in tubes > External pressure.
Entry	Requires revolving doors or airlocks to prevent pressure loss.	Standard doors and windows can be used (can be left open).
Structure	Usually a single skin membrane.	Double skin membrane (creates ribs or arches).
Sketch Idea	Draw a dome where arrows show air pushing up from inside the whole room.	Draw an arch made of inflated tubes (like a bouncy castle beam).

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5. Components of CCTV & Application in Security Systems

A. Components of CCTV (Closed Circuit Television):

Cameras: The "eyes" of the system (Dome, Bullet, PTZ - Pan Tilt Zoom). They capture the visual data.

Lens: Focuses light onto the camera sensor (determines field of view).

Monitor: Displays the video feed for security personnel.

Recorder (DVR/NVR):

DVR (Digital Video Recorder) for analog cameras.

NVR (Network Video Recorder) for IP digital cameras. It stores the footage.

Cabling/Transmission: Coaxial cables (analog) or Ethernet cables/Wi-Fi (digital) to transfer data.

B. Application Potential in Security Design:

Deterrence: Visible cameras discourage criminals from attempting theft or vandalism.

Surveillance/Monitoring: Allows security guards to monitor multiple locations (entrances, parking lots, blind spots) from a single control room.

Evidence Gathering: Recorded footage provides legal evidence in case of a crime or accident.

Access Control Integration: Can be linked with facial recognition to automatically open doors for authorized personnel or trigger alarms for blacklisted individuals.

Remote Viewing: Modern systems allow owners to view feeds via smartphones from anywhere in the world.

Based on the image provided, here are the detailed solutions for the questions under **Q.3 (B)**. Although the exam asks to attempt any two, I have provided answers for all three so you can study the ones you find easiest.

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1. Building Energy Management Systems (BEMS)

What do you mean by BEMS?

BEMS stands for Building Energy Management System. It is a sophisticated, computer-based control system installed in buildings to control and monitor the building's mechanical and electrical equipment.

- It acts as the "brain" of a building, ensuring that the building operates at maximum efficiency.
- It integrates software, hardware, and sensors to gather data on energy usage and automate functions to reduce waste.

What does BEMS attempt to control?

The primary goal of BEMS is to control the building's internal environment to ensure occupant comfort while minimizing energy consumption. It specifically attempts to control:

1. **HVAC Systems:** Regulating heating, ventilation, and air conditioning based on occupancy schedules or temperature sensors (e.g., turning off AC in empty conference rooms).
2. **Lighting Systems:** Controlling lights through timers, motion sensors, or ambient light sensors (daylight harvesting).
3. **Power Systems:** Monitoring voltage and current to prevent overloads and managing peak loads.

4. **Security & Access:** Often integrated to turn off systems in zones that are secured/unoccupied.
5. **Fire & Safety:** Interfacing with fire alarms to control smoke extraction fans and emergency lighting.

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2. Digital Architecture

Explanation:

Digital Architecture refers to the use of computer modeling, programming, simulation, and imaging to create both virtual forms and physical structures. Unlike traditional CAD (which is just digital drafting), Digital Architecture involves using algorithms and data to determine the form and performance of a building. It moves from "drawing lines" to "scripting forms."

Types of Digital Architecture:

- Parametric Design
- Generative Design
- Biomimetic Design
- Topological Design
- Evolutionary Architecture

Explanation of 3 Types (with Sketch ideas):

A. Parametric Design:

- **Concept:** This relies on defining parameters (variables) and rules. If you change one parameter (e.g., the width of a window), the entire geometry of the facade updates automatically to accommodate that change.
- **Example:** Zaha Hadid’s curving structures.
- **Sketch Idea:** Draw a facade where the windows gradually change size or shape in a fluid wave pattern.

B. Generative Design:

- **Concept:** The designer inputs goals (like "maximize sunlight" and "minimize material") into a computer program. The computer then uses algorithms to generate thousands of design variations that meet those goals. It mimics the process of evolution.
- **Example:** Bone-like lattice structures in modern stadiums.

- **Sketch Idea:** Draw a complex, web-like structural column that looks organic rather than a straight pillar.

C. Biomimetic Design:

- **Concept:** This involves using digital tools to analyze and mimic nature's systems and geometries to solve architectural problems.
- **Example:** The Beijing National Stadium ("Bird's Nest") mimics the structural logic of a nest.
- **Sketch Idea:** Sketch a honeycomb structure next to a building facade that uses a hexagonal grid.

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3. Slip Formwork Construction Techniques

Concept:

Slip formwork (or "sliding formwork") is a construction method used largely for tall, vertical structures such as cooling towers, chimneys, elevator cores, and silos. It allows for the continuous pouring of concrete without stopping.

Process:

1. **Continuous Movement:** The formwork (the mold for the concrete) is built about 1 to 1.2 meters high.
2. **Jacking System:** Hydraulic jacks are placed on steel rods embedded in the concrete. These jacks lift the entire formwork assembly upwards at a slow, steady rate (e.g., 30 cm per hour).
3. **Pouring:** Fresh concrete is poured into the top of the formwork.
4. **Setting:** By the time the formwork slides up past a specific point, the concrete at the bottom of the form has hardened enough to support its own weight, while the concrete at the top is still wet.

Key Components (for your sketch):

- **Shuttering/Panels:** The walls of the mold (inner and outer).
- **Yoke Legs:** These connect the inner and outer panels and hold them in place.
- **Working Deck/Platform:** A platform for workers to stand on while pouring concrete.
- **Hydraulic Jacks:** The mechanism that climbs up the jack rods.
- **Jack Rods:** Steel rods that the jacks climb; these are left inside the concrete wall.

Sketch Idea:

Draw a vertical cross-section of a wall. Show the formwork panels on both sides. Draw a "Y" shaped yoke connecting them over the top. Place a jack on the yoke and a rod going through it. Add a small platform for a worker.

Based on the image provided, here are the detailed solutions for **Q.4**. The exam instructions say to "Attempt Any Two," but I have provided solutions for all three so you can choose the ones you are best prepared for.

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1. Design a playing maze for 25 children using the concept of Pneumatic Architecture

Concept:

For a children's maze, the best type of pneumatic structure is an Air-Inflated Structure (Tubular structure). Unlike air-supported structures (bubbles), air-inflated structures use high-pressure air trapped in tubes to create rigid walls. This is safer for kids (bouncy walls) and doesn't require airlocks for entry.

Design Proposal: "The Bubble Grid"

A. Plan (Top View):

- **Grid Layout:** A 10m x 10m area (100 sq. m), sufficient for 25 children.
- **Pattern:** A modular grid of inflated tubular walls (approx. 1.5m thick tubes) arranged to create dead ends and twisting paths.
- **Central Zone:** A wider open area in the center for a "gathering point."
- **Entry/Exit:** Two distinct openings (Start and Finish) to prevent congestion.
- **Annotation:**
    - "High-Pressure Air Tubes (PVC Material)"
    - "1.5m Wide Pathways"
    - "Entry Point" & "Exit Point"
    - "Anchoring Points" at corners.

B. Section (Cut through the maze):

- **Profile:** Show the walls as round circles (cross-section of the tubes) stacked or standing vertically.
- **Height:** The walls should be approx. 1.5m to 2m high—tall enough to hide the path, but low enough for adults to supervise from outside.
- **Floor:** A soft inflated floor mat connected to the walls for safety.
- **Annotation:**
    - "Inflated Tubular Wall (Double skin membrane)"
    - "Internal Air Pressure"
    - "Soft Floor Mat"
    - "Ground Anchor/Sandbags"

C. Elevation (Front View):

- **Appearance:** Looks like a collection of colorful, bulging cylinders.
- **Color:** Bright primary colors (Red, Blue, Yellow) to attract children.
- **Annotation:**
    - "Rounded Profiles"
    - "PVC Coated Polyester Fabric"
    - "Air Pump Unit (External)"

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2. Explain with an example an "Intelligent Building" and identify the intelligent factor.

A. What is an Intelligent Building?

An intelligent building (or Smart Building) uses technology and processes to create a safe, healthy, and comfortable environment for occupants while being energy efficient. It uses an integrated system of sensors and software to "think" and adjust to conditions automatically.

B. Example: The Edge, Amsterdam

Often cited as the smartest building in the world.

- **The Intelligent Factor:** Connectivity and Data Integration.
- It has 28,000 sensors connected to a central dashboard. It knows where every employee is, adjusts the temperature and light preference for their specific workspace via a smartphone app, and even directs cleaning crews only to the parts of the building that were actually used that day.

C. Explanation of Two Parameters:

Parameter 1: Integrated Building Management System (IBMS)

- This is the "brain" of the intelligent building. It connects separate systems (HVAC, Lighting, Security, Fire) into one single interface.
- *Function:* Instead of the AC fighting the heating system, the IBMS coordinates them. If a room is empty (detected by sensors), the IBMS turns off the lights and reduces the AC to save energy.
- *Benefit:* Drastically reduces operational costs and energy waste.

Parameter 2: Occupant Control & Personalization

- This parameter focuses on the user experience. Intelligent buildings allow users to interact with the building, usually via a smartphone app.
- *Function:* Users can locate free desks, find colleagues, control the brightness of the light above their desk, or adjust the temperature in their immediate zone.
- *Benefit:* Increases productivity and user satisfaction.

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3. Attributes of Building Envelope to achieve sustainability through passive cooling strategies

The "Building Envelope" is the physical separator between the conditioned inside and the harsh outside (walls, roof, windows). To achieve sustainability via passive cooling (cooling without AC), the envelope must have specific attributes.

A. Orientation and Shading (Solar Control)

- **Attribute:** The envelope should be designed to block direct sun in summer but admit daylight.
- **Sketch Idea:** Draw a window with a horizontal overhang (Chajja) or louvers blocking high-angle summer sun.
- **Explanation:** External shading devices prevent solar heat gain before it enters the glass.

B. High-Performance Glazing (Fenestration)

- **Attribute:** Windows should have a low Solar Heat Gain Coefficient (SHGC) and low U-value.
- **Sketch Idea:** Draw a section of a double-glazed unit (two panes of glass with an air gap).

- **Explanation:** Double glazing acts as a barrier, stopping outside heat from conducting into the cool interior.

C. Thermal Mass (Time Lag)

- **Attribute:** Using heavy materials like stone, concrete, or mud for walls.
- **Sketch Idea:** Draw a thick wall section with an arrow showing heat trying to enter but getting trapped/slowed down.
- **Explanation:** Thick walls absorb heat during the day (keeping the inside cool) and release it at night when it's cooler outside. This is called "Time Lag."

D. Cool Roofs (Reflection)

- **Attribute:** High Albedo (Reflectivity).
- **Sketch Idea:** Draw a roof with sun rays bouncing off it.
- **Explanation:** Painting roofs white or using light-colored tiles reflects up to 80% of sunlight, significantly reducing heat absorption.

E. Ventilation Openings (Breathability)

- **Attribute:** Strategically placed openings for cross-ventilation.
- **Sketch Idea:** Draw a room with a low window on the windward side and a high window on the leeward side (Stack Effect).
- **Explanation:** Allows hot air to rise and escape, drawing in fresh cool air.