# MAH M Arch CET Environment

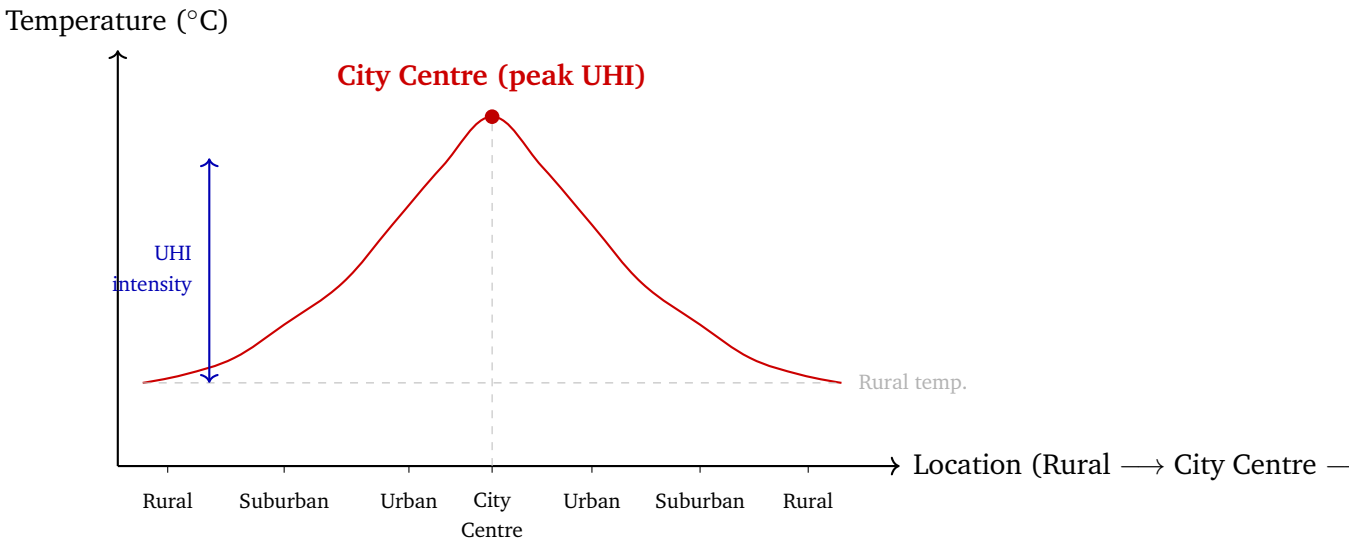
## Sample Paper – 2

**Duration: 12 Minutes** **Maximum Marks: 20**

### Instructions

- This paper contains **10** Multiple Choice Questions (Single Correct Answer), modelled on the Environment portion of **MAH M Arch CET** entrance.
- Each correct answer carries **+2 marks**. There is **no negative marking** for incorrect or unattempted answers.
- Only **one** option is correct. Choose carefully.
- Syllabus: Ecology & Landscape Design, Environmental Design Strategies, Environmental Laws & Regulations.
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

**Q1.** The **Urban Heat Island (UHI)** effect describes the phenomenon where urban areas experience significantly higher temperatures than surrounding rural areas. The figure below shows a typical UHI temperature profile along an urban transect from the rural fringe to the city centre.



Which of the following is the **PRIMARY** cause of the Urban Heat Island effect in cities?

(A) Increased cloud cover and precipitation over urban areas leading to localised greenhouse warming

(B) Reduced vegetation and increased impervious surfaces that absorb and retain more solar radiation, raising ambient temperatures

(C) Concentration of tall buildings that traps cold air at street level, creating temperature inversions year-round

(D) Emissions of industrial greenhouse gases exclusively confined to the urban boundary layer

**Q2.** In a rooftop rainwater harvesting system, the **first flush diverter** is installed between the downpipe and the storage tank. Which of the following BEST describes the purpose of a first flush diverter?

(A) To regulate the flow rate of water entering the storage tank and prevent overflow during heavy rainfall events

(B) To remove suspended sediments, biological matter, and fine particulates from harvested rainwater using a filter medium

(C) To measure and automatically log the volume of rainfall collected per storm event for water auditing purposes

(D) To automatically divert and discard the initial runoff from the roof surface, which carries the highest concentration of accumulated dust, bird droppings, and atmospheric pollutants

**Q3.** A **wind rose diagram** is a standard graphical tool used in climatic analysis and site planning for architecture and landscape design. What does a wind rose diagram PRIMARILY represent?

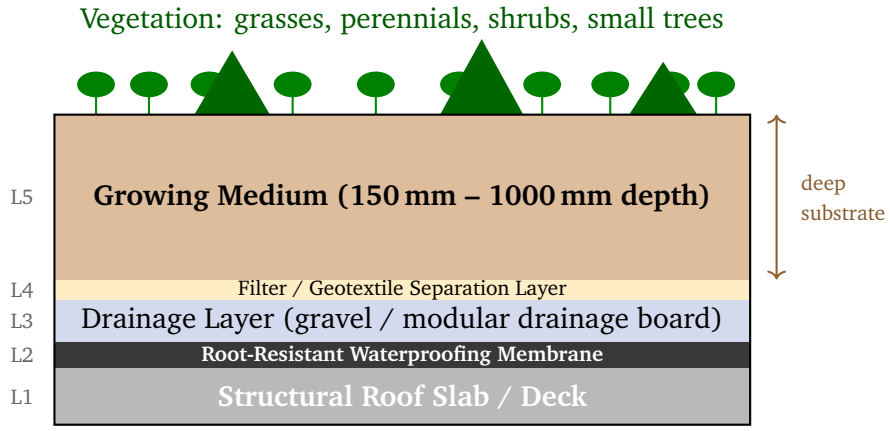
(A) The statistical frequency, direction, and average speed of winds at a specific location over a defined period, clearly indicating the prevailing wind directions

(B) The seasonal variation in wind chill factor and its effect on outdoor thermal comfort across different zones of a site

(C) The pattern of wind-driven rain striking building facades from different cardinal directions during the monsoon season

(D) The pressure differential between windward and leeward faces of a building mass under steady-state wind conditions

**Q4.** Green roofs are broadly classified based on their growing medium depth and the type of vegetation they support. The cross-section diagram below illustrates the layer assembly of a particular green roof system.




Which type of green roof is depicted in the diagram, characterised by a deep growing medium that can support diverse vegetation including shrubs and small trees?

(A) Extensive green roof — thin substrate (60–150 mm), lightweight, low maintenance, restricted to sedums, mosses, and drought-tolerant grasses

(B) Semi-intensive green roof — moderate substrate depth, supports herbaceous perennials only, with periodic manual irrigation

(C) Intensive green roof — deep growing medium (150 mm to over 1000 mm), supports a diverse range of plants from perennials to shrubs and small trees, requires regular maintenance and irrigation

(D) Bio-diverse (brown) roof — deliberately left to self-colonise with minimal substrate, primarily designed for invertebrate and bird habitat creation

**Q5.** In tropical climatic conditions, the sun's path results in low solar altitude angles during morning hours on east-facing facades and during evening hours on west-facing facades. Selecting the correct shading device for each orientation is critical for minimising solar heat gain through glazing. Which shading device is **MOST effective** for **east- and west-facing** facades?

(A) Horizontal overhangs (chajjas), as they intercept high solar altitude angles effectively and can be sized to shade glazing on all orientations

(B) Vertical fins, as they block low-angle morning and evening solar radiation approaching nearly horizontally from the sides — an angle that horizontal overhangs cannot intercept

(C) Egg-crate (combined horizontal and vertical) louvers positioned on the south facade to simultaneously control direct and diffuse sky radiation

(D) Perforated screens on the north facade to reduce glare from the diffuse sky component in the northern hemisphere

**Q6.** The **riparian zone** is an ecologically significant landscape element frequently referenced in environmental planning, landscape architecture, and watershed management. Which of the following statements MOST accurately describes the riparian zone and its buffering function?

(A) The zone of deep, still water at the centre of a large river where aquatic species diversity and biomass production are highest

(B) A raised earthen embankment constructed parallel to a river channel to contain floodwaters and protect adjacent agricultural land from inundation

(C) A transitional coastal zone between tidal mudflats and terrestrial upland, characterised by halophytic mangrove and salt-marsh plant communities

(D) The band of vegetation along the margins of a river, stream, or other water body that intercepts surface runoff, filters pollutants, stabilises stream banks, moderates water temperature, and provides ecological connectivity between aquatic and terrestrial habitats

**Q7.** Bioswales are engineered linear landscape features increasingly integrated into urban streetscapes, parking areas, and green infrastructure networks as components of Low Impact Development (LID) / Sustainable Urban Drainage Systems (SUDS). What is the **PRIMARY function** of a bioswale in urban stormwater management?

(A) To convey, slow down, and biologically filter stormwater runoff through a gently sloped vegetated channel, allowing suspended pollutants to settle and water to gradually infiltrate into the underlying soil

(B) To collect large volumes of rainwater in an underground cistern lined with an impervious membrane for later non-potable reuse in toilet flushing

(C) To rapidly channel all surface stormwater into municipal underground drainage networks to minimise surface ponding and flooding risk

(D) To supply supplemental drip irrigation to street trees and landscape plantings from stored stormwater during dry periods between rainfall events

**Q8.** The concept of **carrying capacity** is fundamental to population ecology, wildlife management, and sustainable development planning. Which of the following BEST defines carrying capacity in an ecological context?

(A) The maximum total biomass, expressed in tonnes per hectare, that a mature forest or grassland ecosystem can accumulate over its entire successional lifespan

(B) The intrinsic rate of natural increase ($r$) of a species relative to its age-specific mortality rate within a defined territorial boundary

(C) The maximum population size of a given species that a particular environment can sustainably support over the long term, given the finite availability of food, water, shelter, and other essential resources

(D) The minimum viable population size required to avoid inbreeding depression, demographic stochasticity, and genetic bottleneck effects in a fragmented habitat patch

**Q9.** The **Forest (Conservation) Act, 1980** is a central legislation in India enacted to check indiscriminate deforestation and to protect forest land from conversion. Under this Act, which of the following activities requires **prior approval of the Central Government** before it can be carried out?

(A) Conducting biodiversity surveys and non-invasive scientific research within notified forest areas, supervised and permitted by the State Forest Department

(B) Diversion of forest land for non-forest purposes such as construction of roads, dams, power transmission lines, mining operations, or industrial projects

(C) Large-scale afforestation and plantation activities undertaken by State Forest Departments within notified degraded forest areas as part of compensatory programmes

(D) Collection of non-timber forest produce (NTFP) such as honey, medicinal plants, and minor produce by Scheduled Tribes in accordance with their traditional livelihood rights under the Forest Rights Act, 2006

**Q10.** The **Coastal Regulation Zone (CRZ) Notification, 2019** regulates permissible development activities along India's coastline by dividing coastal

areas into four categories based on ecological sensitivity, level of development, and land use. Which CRZ category is specifically designated for **ecologically sensitive areas** where most construction activities are prohibited?

(A) CRZ-II — Urbanised coastal stretches within or contiguous to municipal limits, where construction is permitted on the landward side subject to specified Floor Space Index restrictions

(B) CRZ-III — Rural and relatively undisturbed coastal areas sub-classified into CRZ-III A (densely populated) and CRZ-III B (others), permitting limited development beyond a defined No-Development Zone

(C) CRZ-IV — Territorial waters and tidal-influenced water bodies including rivers, creeks, and backwaters, where activities adversely impacting water quality are restricted

(D) CRZ-I — Ecologically sensitive areas (ESAs) such as mangroves, coral reefs, sand dunes, biologically active mudflats, national parks, wildlife sanctuaries, and their ecotones, where construction activities are largely prohibited to protect ecological integrity

## Detailed Solutions

**Q1.**

**Solution**

**Concept:** The Urban Heat Island (UHI) effect arises from the altered physical and thermal properties of urban surfaces compared to natural, vegetated land.

**Step 1 — The role of vegetation loss:** Natural vegetation in rural areas absorbs solar radiation but converts a large proportion of it into latent heat through evapotranspiration, which cools the air. When urban development replaces vegetation with impervious surfaces — asphalt roads, concrete rooftops, and paved plazas — this evaporative cooling is eliminated.

**Step 2 — Heat absorption by impervious surfaces:** Dark impervious surfaces have low albedo (high solar absorptance) and high thermal mass. They absorb solar radiation intensively during the day and re-radiate longwave (infrared) heat back into the urban canopy throughout the night, sustaining elevated temperatures. Anthropogenic heat from vehicles, HVAC systems, and industry compounds the effect but is not its primary cause.

**Why other options are wrong:**

- **(A)** Urban areas do not systematically experience more cloud cover; UHI often reduces relative humidity through the loss of evapotranspiration.
- **(C)** Tall buildings reduce wind speed (reducing convective cooling) and increase surface area for heat absorption, but do not trap cold air.
- **(D)** Industrial greenhouse gas emissions are a global climate driver; UHI is a localised surface-energy phenomenon not caused by GHGs alone.

**Answer: (B)** Go Back to Q1

**Q2.**

**Solution**

**Concept:** Rainwater quality is at its poorest at the start of a storm event. The first flush diverter is a passive device that addresses this "first flush" problem.

**Step 1 — Why the first flush is contaminated:** Before a rain event, rooftop surfaces accumulate dust, atmospheric particulates, bird droppings, fungal spores, and pollen. When rain begins, the first portion of runoff washes this accumulated contamination off the surface into the downpipe. This initial runoff has very high concentrations of suspended solids, faecal coliforms, heavy metals, and nutrients

compared to subsequent runoff from the same storm.

**Step 2 — Mechanism of the diverter:** A first flush diverter is installed in the downpipe. The initial runoff fills a bypass chamber sized to capture approximately 20–25 litres per 100 $m^2$ of collection area. Once this chamber is full, the cleaner subsequent runoff is automatically redirected via a ball-float valve or tipping mechanism to the storage tank.

**Why other options are wrong:**

- **(A)** Flow rate regulation is achieved by a float valve, a header tank overflow pipe, or a level controller, not a first flush diverter.
- **(B)** Particulate filtration is the function of a mesh screen, sand filter, or cartridge filter installed downstream of the diverter.
- **(C)** Volume measurement is performed by a rain gauge or an inline flow meter, not a diverter.

**Answer: (D)** Go Back to Q2

## Q3.

### Solution

**Concept:** A wind rose is a polar frequency diagram that summarises wind observations collected at a meteorological station over a defined period (typically one year or a full climatic dataset).

**Step 1 — Structure of a wind rose:** The diagram is drawn on a polar grid centred on the station location. Radiating spokes point in each of 8 or 16 compass directions. The length of each spoke is proportional to the percentage of time the wind blows *from* that direction (frequency). Each spoke is subdivided into coloured or patterned speed bins representing calm, light, moderate, and strong winds. The central circle represents the percentage of time with calm (near-zero) conditions.

**Step 2 — Application in site analysis:** In architectural and landscape site analysis, the wind rose helps designers identify prevailing wind directions for natural ventilation strategy, position building openings for cross-ventilation, orient structures to capture cooling breezes, and locate windbreaks or shelterbelt plantings to reduce wind loads and dust intrusion.

**Why other options are wrong:**

- **(B)** Wind chill is a thermal comfort index derived from temperature and wind speed; it is not directly depicted by a wind rose.

- **(C)** Wind-driven rain analysis requires combined rainfall intensity and wind data; it is a separate calculation, not a wind rose output.
- **(D)** Pressure differentials around a building require Computational Fluid Dynamics (CFD) simulation or wind tunnel testing, not a wind rose.

**Answer: (A)** Go Back to Q3

## Q4.

### Solution

**Concept:** Green roofs are classified primarily by their growing medium (substrate) depth, which determines plant palette, structural load, maintenance intensity, and hydrological performance.

**Step 1 — Comparison of the two principal types:**

- **Extensive green roof:** Substrate depth 60–150 mm; saturated weight 60–150 kg/m$^2$; restricted plant palette of sedums, mosses, and drought-tolerant grasses; virtually maintenance-free; no irrigation required after establishment.
- **Intensive green roof:** Substrate depth 150 mm to over 1000 mm; saturated weight 180–500+ kg/m$^2$; wide plant palette from herbaceous perennials to shrubs and small trees; functions as an accessible rooftop garden; requires regular irrigation, fertilisation, pruning, and maintenance.

**Step 2 — Reading the diagram:** The cross-section shows five distinct layers — structural slab, root-resistant waterproofing membrane, drainage layer, filter/geotextile, and a deep growing medium annotated at 150–1000 mm — surmounted by a diverse vegetation canopy including shrubs. This layer depth and plant diversity definitively characterise an **intensive green roof**.

**Why other options are wrong:**

- **(A)** An extensive green roof has thin substrate (60–150 mm) and cannot sustain the shrubs and deep root systems shown in the diagram.
- **(B)** Semi-intensive is an intermediate category with moderate substrate depth; it does not match the deep substrate and shrub layer illustrated.
- **(D)** A bio-diverse (brown) roof uses minimal substrate and relies on natural colonisation for habitat; it does not have the engineered, layered horticultural assembly shown.

**Answer: (C)** Go Back to Q4

## Q5.

**Solution**

**Concept:** Shading device effectiveness depends critically on the solar altitude angle of the sun relative to the facade orientation being shaded.

**Step 1 — Solar geometry for east/west orientations:** On east-facing facades, the rising sun strikes the surface at low altitude angles in the morning (roughly $15°$–$45°$ above the horizon, depending on season and latitude). On west-facing facades, the afternoon sun similarly approaches at low angles. A horizontal overhang (chajja) works by projecting horizontally outward from above the window; it casts a downward shadow effective only when the sun is *high* in the sky. When the sun is low on the horizon, it approaches nearly horizontally and slides under a horizontal overhang without obstruction.

**Step 2 — Why vertical fins work for east/west:** Vertical fins project perpendicularly from the facade plane. When the low-angle morning or evening sun approaches nearly horizontally from the side, the vertical fin intercepts and blocks the beam. The fin depth, spacing, and angle can be optimised for the specific latitude and desired shading hours. This is the standard design prescription for east- and west-facing facades in tropical architecture.

**Why other options are wrong:**

- **(A)** Horizontal overhangs are the correct device for south-facing (equator-facing) facades where the midday sun is high in the sky.
- **(C)** Egg-crate louvers combine horizontal and vertical elements and are suitable for south-east or south-west orientations; the question asks for the single *most* effective device for east/west.
- **(D)** North-facing facades in the northern hemisphere receive minimal direct solar radiation; perforated screens there address diffuse sky glare, not solar heat gain.

**Answer: (B)** Go Back to Q5

## Q6.

### Solution

**Concept:** The riparian zone (from Latin *ripa*, meaning riverbank) is the ecotonal interface between terrestrial and aquatic ecosystems along the margins of water bodies.

**Step 1 — Ecological definition:** The riparian zone is the vegetated land immediately bordering rivers, streams, lakes, and wetlands. It is characterised by moisture-dependent species (riparian willows, reeds, sedges, alder), high biodiversity, and dynamic hydro-geomorphic processes. Its width varies from a few metres alongside small streams to hundreds of metres alongside large rivers.

**Step 2 — Buffering functions:**

- **Water quality filter:** Intercepts surface runoff and subsurface lateral flow, trapping sediments and excess nutrients (nitrogen, phosphorus) before they enter the waterway, reducing eutrophication risk.
- **Erosion and bank stabilisation:** Dense root systems bind the stream bank, preventing undercutting and lateral erosion during floods.
- **Microclimate regulation:** Riparian tree canopy shades streams, maintaining cooler water temperatures essential for cold-water fish species.
- **Habitat corridor:** Provides a continuous linear corridor linking inland habitats, facilitating wildlife movement across fragmented landscapes.

**Why other options are wrong:**

- **(A)** The deep-water centre of a river is the pelagic or benthic zone, not the riparian zone.
- **(B)** Raised earthen embankments are engineered levees or flood bunds, not the naturally vegetated riparian zone.
- **(C)** Mangrove and salt-marsh zones are intertidal coastal/estuarine features; they are distinct from the freshwater riparian concept in this question.

**Answer: (D)** Go Back to Q6

## Q7.

### Solution

**Concept:** A bioswale is a core component of Low Impact Development (LID) / Sustainable Urban Drainage Systems (SUDS), designed to manage stormwater at or near its source rather than conveying it away in pipes.

**Step 1 — Physical description:** A bioswale is a gently sloped (typically 1–5% longitudinal gradient), vegetated open channel planted with native grasses, sedges, and moisture-tolerant plants. Its cross-section is typically trapezoidal or parabolic. It receives stormwater runoff from adjacent impervious surfaces such as roads, car parks, and building rooftops.

**Step 2 — Functional mechanisms:**

- **Velocity reduction:** Vegetation provides hydraulic roughness, slowing the flow and reducing downstream erosion and peak discharge.
- **Pollutant removal:** Suspended sediments, hydrocarbons, heavy metals, and nutrients settle out of the slowed water and are adsorbed by the soil matrix; plant roots and soil micro-organisms biodegrade organic pollutants.
- **Infiltration and groundwater recharge:** Water percolates through the permeable swale base, replenishing groundwater and reducing total runoff volume.

**Why other options are wrong:**

- **(B)** Underground cisterns with impervious membranes are rainwater harvesting tanks or retention vaults, not bioswales (which are open, permeable, and vegetated).
- **(C)** Rapid conveyance to underground drains is the conventional "grey" drainage philosophy, the antithesis of LID/SUDS.
- **(D)** Supplemental irrigation is at best a secondary co-benefit; it is not the primary stormwater management function of a bioswale.

**Answer: (A)** Go Back to Q7

## Q8.

### Solution

**Concept:** Carrying capacity (denoted $K$) is a foundational parameter in population ecology derived from the logistic growth model.

**Step 1 — Mathematical basis:** In the logistic growth model, a population grows rapidly when small but slows as it approaches the environmental ceiling $K$. At $K$, the birth rate equals the death rate and net population growth is zero. This is expressed as:

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

where $N$ is current population size and $r$ is the intrinsic rate of natural increase. The term $(1 - N/K)$ is the *resistance* factor — as $N$ approaches $K$, resistance approaches 1 and growth approaches zero.

**Step 2 — Limiting factors determining $K$:** Carrying capacity is set by the availability of food, water, shelter, nesting sites, and disease pressure. In planning and conservation, $K$ is used to determine sustainable visitor capacities for nature reserves, optimal stocking densities for grazing lands, and maximum human population densities that can be supported by local resource bases.

**Why other options are wrong:**

- **(A)** Maximum ecosystem biomass describes Net Primary Productivity (NPP) and standing crop; this is not carrying capacity.
- **(B)** The ratio of birth rate to mortality describes $r$ (intrinsic rate of natural increase), not $K$.
- **(D)** Minimum viable population (MVP) is the threshold below which extinction risk becomes unacceptably high — the opposite end of the population spectrum from $K$.

**Answer: (C)** Go Back to Q8

## Q9.

### Solution

**Concept:** The Forest (Conservation) Act, 1980 (FC Act) was enacted to halt large-scale deforestation by making the Central Government the ultimate authority over any decision to convert forest land to non-forest use.

**Step 1 — Core provision (Section 2):** Section 2 of the FC Act prohibits any State Government or other authority from permitting the use of forest land for

any *non-forest purpose* or from assigning forest land by way of lease or otherwise to any private organisation without the prior approval of the Central Government. "Non-forest purpose" is broadly defined and includes clearing or breaking up of forest land for cultivation of cash crops, horticulture, construction of roads, dams, canals, power transmission lines, mining, quarrying, and industrial or commercial activities.

**Step 2 — Approval process:** A diversion proposal must be submitted by the State Government through the Regional Empowered Committee (REC) to the Forest Advisory Committee (FAC) of the Ministry of Environment, Forests and Climate Change (MoEFCC). The FAC examines ecological sensitivity, compensatory afforestation requirements, and Net Present Value (NPV) of diverted forest. Only after Stage I (in-principle) and Stage II (final) Central Government approvals can the diversion proceed on the ground.

**Why other options are wrong:**

- **(A)** Non-invasive scientific research within forests is permitted by state forest departments under general forest regulations; it does not constitute "diversion" under the FC Act.
- **(C)** Afforestation by State Forest Departments is actively encouraged and does not require Central Government approval; it is not a non-forest use.
- **(D)** NTFP collection by Scheduled Tribes as traditional rights is protected under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, and is not classified as a non-forest purpose under the FC Act.

**Answer: (B)** Go Back to Q9

## Q10.

### Solution

**Concept:** The CRZ Notification, 2019 classifies India's coastline into four zones based on ecological sensitivity, existing development, and administrative designation.

**Step 1 — CRZ-I: the most protected category:** CRZ-I is divided into two subcategories:

- **CRZ-IA:** Ecologically Sensitive Areas (ESAs) identified by the MoEFCC, including mangroves, coral reefs, salt marshes, sea-grass beds, turtle nesting grounds, horseshoe-crab habitats, sand dunes, and biologically active mud-

flats. No new construction is permitted; only conservation, restoration, and management activities may be carried out.

- **CRZ-IB:** The intertidal zone between the Low Tide Line (LTL) and the High Tide Line (HTL). Strictly no construction of any kind.

**Step 2 — Policy rationale:** CRZ-I receives the most stringent protection because its constituent ecosystems provide irreplaceable coastal defence services (storm surge attenuation, wave energy dissipation, shoreline stabilisation), biodiversity conservation (nursery habitat for commercially important fish), and carbon sequestration (blue carbon in mangroves and sea-grass beds). Once destroyed, these ecosystems are extremely difficult or impossible to restore.

**Why other options are wrong:**

- **(A)** CRZ-II covers already urbanised coastal stretches within municipal limits, where regulated construction on the landward side is permitted subject to Floor Space Index norms.
- **(B)** CRZ-III covers rural and relatively undisturbed coastal areas; limited development is permitted beyond a specified No-Development Zone distance from the HTL.
- **(C)** CRZ-IV covers the water area of tidal-influenced water bodies (rivers, creeks, backwaters) and the 12-nautical-mile territorial sea; it regulates activities in the water column, not the ecologically sensitive land areas.

**Answer: (D)** Go Back to Q10

# Answer Key

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | B | 2 | D | 3 | A | 4 | C | 5 | B |
| 6 | D | 7 | A | 8 | C | 9 | B | 10 | D |