Principles of Architecture

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1.1 Nature of Architecture

Human beings have certain physical needs without which they cannot survive. Some of these, such as air and water, are naturally available. The others are food, shelter, and clothing. With minor exceptions, these are not readily available in nature and have to be procured from the environment. Food material has to be cultivated, processed, and cooked: shelter has to be constructed; clothing has to be manufactured. These basic requirements have to not only be produced but also provide a degree of satisfaction.

As the human society evolved, great changes took place. The activities required for mere survival became less important and civilizing activities began to develop. Man refined his food, shelter, and clothing to provide not only physical satisfaction but also aesthetic pleasure. The following changes took place. Different types and preparations of food were available. Clothes were no longer just fabrics wrapped around the body, but tailored and embroidered according to personal tastes. Shelters, in the form of buildings, were given conscious forms and decorated. Aesthetics—beauty and taste—became important. Objects which had only utility values also came to have emotional values. These are nothing but the psychological needs of human beings.

What is Aesthetics?

The word aesthetics is derived from a Greek word meaning ‘a perceiver’ or ‘sensitive’. It is a branch of philosophy dealing with the nature of beauty. The word aesthetics was first used by German philosopher Alexander Gottlieb Baumgarten. It can be used as a noun meaning ‘that which appeals to the senses’.
One way of understanding the meaning of ‘aesthetic’ is by comparing it to its antonym, ‘anaesthetic’. The word ‘anaesthetic’ implies something that tends to dull the senses or causes sleepiness. In contrast, aesthetic may be thought of as anything that tends to enliven or invigorate or wake one up.

With these changes, every object—clothing, dwelling, vessel, etc.—became both useful and beautiful. Beauty did not exist separately but was merged or fused with the primary needs.

1.1.1 Technology, art and craft

For a better understanding of the concept of aesthetics, we must understand the difference between technology, art, and craft/design. Let us consider three kinds of people:

- Technologist
- Artist
- Craftsman

**Technologist**

A technologist is a person who is concerned with the scientific aspect of a project/activity. For example, when engineers are given the task of designing a bridge, the various factors they consider are

- purpose of construction
- strength
- cost
- functional requirements such as site conditions and materials

Based on these factors, they make a series of calculations and estimate the cost of the proposed structure. They perform analysis and use logic, based upon scientific and mathematical laws. At no stage are the engineers concerned with the aesthetic appearance of the bridge. The concepts of beauty and ugliness do not enter into any of their calculations. The engineer sees the bridge as an object for satisfying primary human needs. This kind of basic activity is done by the technologist. Similarly, a civil engineer, mechanical engineer, physicist, physician, chemical engineer, etc. thus does not take into account the need for aesthetics.

**Artist**

When an artist paints, the theme he selects may or may not be useful to his client or the general public. He paints to convey his inner feelings about a subject and not to please anyone. His concern is not whether the painting will be sold, because his only aim is to express his emotions and thoughts through the medium of painting. Thus, he will ignore all subjective conditions such as the viewer’s satisfaction, the cost involved, and the utility of his work. The effect of the painting will be judged by the emotional response it stimulates in
the observer. Other fields concerned with emotional response are music, poetry, and sculpture.

**Craftsman**

When a craftsman is given the problem of designing a piece of furniture, say, a kind of chair, he considers its utility or functional aspects such as

- type of wood
- size of the chair
- overall strength
- joinery details
- cost

After considering the functional requirements he thinks about giving a *form* to the chair. Deciding on the form is an aesthetic problem and the carpenter becomes an artist, as form creates emotional feelings.

The chair, however beautiful, could be functionally defective if the carpenter chooses to make it with excessively slender legs. It will fail when put to use—in other words, it will break.

In this example, two criteria are involved

\[
\begin{array}{ccc}
\text{Utility} & \Rightarrow & \text{Utility} \\
+ & + & + \\
\text{Emotional} & \Rightarrow & \text{Beauty} \\
& & \text{Aesthetic}
\end{array}
\]

That is, in designing a chair, both the functional and the aesthetic requirements should be satisfied. The chair must not only look beautiful, it must also perform well. A chair which is aesthetically pleasing may be uncomfortable to sit on. Thus, the choice of material, size, shape, form should satisfy both criteria. For example, a coarse-grained wood though technically satisfying may not be aesthetically satisfying.

As they move up the social scale, human beings want to see utility and beauty brought together in items of personal use, e.g., furniture, clothing, and housing. Modern life is so complex that the physical needs are satisfied by the technical specialist and the emotional needs are satisfied by the aesthetic specialist.

Craftsmanship includes, among others, the fields of pottery, carpentry, blacksmithy, interior design, architecture, and dress design. All these fields deal with the concept of *design*.

### 1.1.2 Definition of Architecture

The meaning of architecture has undergone many changes during the evolution of human civilization. Earlier, architecture was identified with large elaborate buildings such as palaces built by rulers to house their families and armies, and to impress their subjects. The aim was to display status and prestige. Shelters for the common people were not considered fit for the architect to design. As religion became organized, architecture became important for spiritual needs. To satisfy spiritual needs, temples, churches, and mosques were constructed.
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In modern society, architecture is concerned with every building task. From public toilets to individual homes, all constructions have become objects of architectural design. The scope of architecture has broadened to include much more than individual buildings. It includes

- town planning
- regional planning
- urban design
- urban planning
- landscape architecture

Architecture is a form of craftsmanship intended to serve a basic human need. These are

- need for shelter
- need for an environment

Both should be designed to be technically and aesthetically satisfactory.

The various building types which involve architectural design are

- dwellings
- schools
- hospitals
- places of worship
- railway stations
- cinemas
- stadiums
- playgrounds

The common factor in this list of diverse buildings and areas is the concept of space. Space is a specific volume intended for a specific form of human activity. Nature has provided natural spaces such as valleys, caves, and groups of trees, which have served in the past for human activities. These are not architectural. Architectural space is man made, it must result from the deliberate use of materials; it must be technically efficient and aesthetically satisfying. The aesthetic aspect should not be coincidental as in an electric motor (which could be made beautiful, but costly and less efficient), but should reflect the art of creativity.

Architecture can be defined as the conscious creation of spaces for utility, constructed from materials in such a way that the whole is both technically and aesthetically satisfying. It is a fusion of art and technology. Some examples of aesthetic statements commonly used are a red wall or a rough-textured surface, a brilliant red, a delightful contrast, and a beautiful proportion. To define something as aesthetically satisfying is similar to describing physical qualities in emotional terms. Architecture involves the selection of forms and spaces.

An architect deals with the design of the built environment, i.e., design of the actual building, its enclosed space, and the surrounding space. On the other hand, a civil engineer is mainly concerned with the structural aspect of the building. The main objective of this course is to sensitize students of civil engineering to the relation between architecture and engineering.
Architecture is a design process which results in functionally efficient, economically viable, and aesthetically pleasing buildings.

### 1.2 Definitions of Architectural Terms

The theory of architecture involves many technical terms. The definitions of some of the important terms are given in this section.

#### 1.2.1 Aesthetics

Aesthetics concerns beauty or the appreciation of beauty. In other words, it refers to the philosophy behind a pleasing appearance. The set of principles involved in the work of people in fields concerned with design, to make the end product beautiful, is known as aesthetics. It is directly influenced by the artistic taste of the person involved.

Aesthetics is concerned with bringing art into the daily aspects of life, such as the taste and presentation of food, and the colour and design of clothes. Similarly, humans also desire beautiful buildings to live and work in. The form of a building is decided mainly by aesthetics. When a building is designed, the aesthetic aspects can be satisfied by using elements (Fig. 1.1) such as sloped roofs, decorative columns, roofs for window elements, and semicircular or segmental arches.

![Fig. 1.1 An example of aesthetic elements](image)

The elements of aesthetics are:
- mass and space
- proportion
- symmetry
- balance
- contrast
- pattern
- decoration
- massing
1.2.2 Planning

Planning involves the systematic steps to be carried out in order to achieve a given objective or target. For example, planning a construction means identifying the various steps or activities to be completed in order to carry out the construction in the given amount of time. It could involve the following steps:

- clearing the site for construction
- procuring the material for construction
- marking the plan on the site
- the construction process
- finishing and handing over the project

In the smaller, individual sense, planning is the process of preparing for personal requirements. In the larger sense, local governments control building and development through town planning.

1.2.3 Designing

Designing [Figs 1.2(a) and (b)] is the process of procuring a preliminary sketch of an object that is to be physically constructed later. The original idea behind the sketch is called the concept of design. It can exist in two different forms:

- mental idea
- representational idea

The mental idea helps to
- identify the purpose of the object (building)
- analyse the aesthetic and functional aspects
- think of a good solution (design)

The representational idea simply reproduces the mental map of the building in the form of sketches or diagrams or as a miniature model.

1.2.4 Creating

Creating [Fig. 1.2(c)] is the actual process of execution, where the design is converted into a physical reality. The process of creating an object involves the processes of

- designing
- planning
- incorporating the functional and aesthetic aspects

When all these processes have been completed, an object has been created. Buildings by architects, paintings by artists, or furniture made by carpenters are examples of creations.
1.2.5 Erecting

Erecting is the process of assembling or putting into place the completed or fabricated components of a building. Consider the following examples.

(a) Erecting roof trusses in industrial buildings and workshops: The roof trusses are lifted by cranes and placed in position exactly on the walls (Fig. 1.3). The trusses are then connected to the walls or columns by bolting the base plate.

(b) Erecting precast elements of a building: The partition walls, heavy beams, columns, etc. are manufactured in a factory or at the construction site by prefabrication. Then these units are brought to the site and erected. This is done by lifting the precast elements using pulley blocks, a tripod, and winches or cranes (Fig. 1.4).
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(c) Erecting multi-storey buildings: Multi-storey buildings are nowadays erected using a tower crane; the panel walls, windows, doors, etc. are lifted and placed on different levels or storeys. Erecting buildings with precast elements helps to complete the construction quickly.

1.2.6 Constructing

Constructing is the process of making or building any type of structure. Construction requires planning, designing, and procurement of material, labour, or machinery for building the structure. Proper management of the different activities involved in construction is necessary.

Construction at a site starts with site analysis, reconnaissance, and building a temporary structure at the site for storage of material, security, road laying, water and electricity connections, etc.

The type of construction (whether brick masonry or framed structure) is identified depending on the function of the building and the total design is completed before starting the construction. The procurement of material and the construction work starts after that. After the completion of the building, other services such as water supply, electricity installation, and sewage disposal system are put in place. Once all the phases of construction are completed, the building is complete in all respects and ready for use.

1.2.7 Executing

Executing is the completion of all the activities connected with the construction. Executing a contract means completing all the jobs included in the contract of the project or the building work, according to the terms and conditions stipulated in the contract. Executing simply means to complete any job, be it the entire contract or any part of it.

1.3 Understanding the Basic Elements of Design

This section discusses the basic or primary elements of design, namely, point, line, plane, and volume (Fig. 1.5). A design is nothing but the creation of a form. A pictorial form begins with the ‘point’ that sets itself in motion. The point moves and the line, which is one-dimensional, comes into being. If the line shifts to form a ‘plane’, we obtain a two-dimensional element. In the
movement from planes to spaces, the clash of planes gives rise to a volume (three-dimensional element). In this section, each element of design or form is explained in the order of growth, as the sum of the kinetic energies which move—a point to produce a line; a line to produce a plane; a plane to produce a volume.

Each element is described first as a conceptual element and then as a visual element in the vocabulary of architectural design.

1.3.1 Point

A point is the prime generator of form. It indicates a position in space. It has no length, width, or depth and, therefore, is static, directionless, and centralized (Fig. 1.6).
As shown in Fig. 1.7(a), a point can serve to mark:
- the two ends of a line,
- the intersection of two lines,
- the meeting of lines at the corner of a plane or volume, and
- the centre of a field or environment.

Fig. 1.7 Characteristics of a point

As shown in Fig. 1.7(b), a point has no shape or form. It makes its presence felt when placed within a visual field. When the point is at the centre, it is stable, at rest and dominates its field. As shown in Fig. 1.7(c), when it is moved off-centre, its field becomes more aggressive and a visual tension is created between the point and its field.

A point has no dimension. To visibly mark a position in space or on the ground plane, a point must be projected onto a vertical linear element such as a column or a tower, as shown in Fig. 1.8. The column in a plan marks a point.

Fig. 1.8 Point projected into a linear element: column, obelisk, or tower
The circle, cylinder, and sphere are point-generated forms (Fig. 1.9).
In a plan, two points can be used to denote a gateway. These two points when elevated denote an approach, as shown in Fig. 1.10.

1.3.2 Line

A point when extended becomes a line. A line has length, but no width or depth. It represents a point in motion and expresses direction, movement, and growth visually (Fig. 1.11).
A line can serve to (See Fig. 1.12):
- join, link, support, surround, or intersect other visual elements,
- describe the edges of and give shapes to planes, and
- articulate the surfaces of planes.

Since a line has only one dimension, it must have some thickness or character (see Fig. 1.13) to become visible. A line that is thick enough to be considered a rectangle is still considered a line, as its length dominates its width. The character of line, whether bold or graceful, is determined by our perception of its length-to-width ratio and its contour.

**Fig. 1.12** Lines help in the formation of various visual elements

**Fig. 1.13** The character of line—bold, graceful, repetitive, etc.
As shown in Fig. 1.14, the orientation or direction of a line denotes the horizontality or verticality of a visual construction.

Another orientation is denoted by the oblique line, which is formed by a deviation from the perpendicular or the horizontal. In other words, it is a falling vertical line or a rising horizontal line. This is illustrated in Fig. 1.15.

Vertical linear elements such as columns, pedestals, and towers have been used throughout history to commemorate significant events. Some examples of such structures are shown in Fig. 1.16.
As shown in Fig. 1.17, vertical linear elements are also used to define transparent volumes of space. In this figure, the four minaret towers define a spatial field from which the dome rises.

In Fig. 1.18, the linear element, the path, which is a visible element, is simply an axis about which elements are symmetrically arranged.
Lines also articulate the edges and surfaces of planes and volumes. Such lines can be drawn between building elements such as frames, around the window or door openings (Fig. 1.19), or in the form of a structural grid of columns and beams (See Figs 1.20 and 1.21). These linear elements affect the building surface’s texture, which depends on the direction and spacing of these elements.
Fig. 1.21 Crown Hall, Illinois Institute of Technology, Chicago articulates a structural grid of columns and beams

Fig. 1.22 A bridge (in Switzerland)—linear elements suggest movement across space

Linear elements are used to express movement across space as shown in Fig. 1.22, provide support for the overhead plane as shown in Fig. 1.23, and form a three-dimensional structural frame for architectural space as shown in Fig. 1.24.
Fig. 1.23 The Erechthon in Athens—linear elements (columns) provide support for the overhead plane.

Fig. 1.24 Imperial Villa, Japan—linear elements form a three-dimensional structural frame for architectural space.
**Linear elements defining planes**  
When a line is shifted or moved, it becomes a plane with the following properties:
- length and width
- shape
- surface
- orientation
- position

Two parallel lines can visually describe a plane. A row of columns represents an open wall with discontinuities at several places.

Figure 1.25 illustrates the transformation of a row of round columns (lines). The row initially supports a portion of a wall (plane); the columns then become square piers (part of the wall plane); finally, remnants of the original column occur as a relief along the surface of the wall.

**Fig. 1.25 From line to plane**
Linear elements define planes:
- A row of columns can be used to define the front façade of buildings—particularly public buildings as shown in Fig. 1.26.
- A colonnaded façade can easily be penetrated for entry and forms a semi-transparent screen—'A public face' that unifies the individual building forms behind it.

In addition to the structural role, columns play an important role in supporting the overhead roof planes. They can also articulate the edges of interior spatial zones, as shown in Fig. 1.27.
Fig. 1.28 A house in California illustrating horizontal overhead linear members.

Figure 1.29 illustrates two contrasting examples—columns articulating the edges of a building form in space as well as the edges of an exterior space defined within a building form.

- Horizontal overhead linear members provide for a moderate degree of enclosure of outdoor space, allowing filtered sunlight and breeze to penetrate. See Fig. 1.28.
Vertical and horizontal linear elements together can define a volume of space. This is illustrated in Fig. 1.31.

Figure 1.30 clearly illustrates the second case. It shows columns lining an external space that is defined within a building form.

**Fig. 1.30** Columns articulating the edges of an exterior space defined within a building form

**Fig. 1.31** Vertical and horizontal linear elements defining a volume of space

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1.3.3 Plane

A line when extended becomes a plane (Fig. 1.32). A plane has a length and a width but no depth. The primary character of a plane is its shape, which is determined by the contour of the line forming the edges of plane. The surface properties of a plane are colour and texture. Planes in architecture define three-dimensional volumes of form and space. Different planes can be manipulated in architectural design.

Fig. 1.32 From lines to planes
There are three different types of planes in architectural design.
(a) The overhead plane: This can either be the roof plane, a building’s primary protection against climatic elements, or the ceiling plane, the sheltering element in architectural space (Fig. 1.33(b)).
(b) The wall plane: Vertical wall planes are usually the most active in defining and enclosing space (Fig. 1.33(a)).
(c) The base plane: The ground plane provides physical support and the visual base for building forms (Fig. 1.33(b)).

**Plane elements in architecture**
The ground plane supports all architectural construction. The climatic, geographical, and topographical conditions of the site affect the form of the building that rises from the ground plane. The building can merge with the ground plane (Fig. 1.34), sit on it (Fig. 1.35), or be elevated above it (Fig. 1.36).
The ground plane could be elevated to honour a sacred place. It could be carved or terraced to provide a suitable platform on which the building can be built. It could be stepped to allow changes.

Fig. 1.35 Temple in Thebes—The building sits on the ground plane

Fig. 1.36 The Spanish Steps (in Rome)—The building is elevated above the ground plane
The floor plane supports the activities within buildings (Fig. 1.37). The interior wall planes define and enclose the building space or rooms.

Like the ground plane, the floor plane can be stepped or terraced, creating platforms for sitting, viewing performances, etc. (Fig. 1.38).

Fig. 1.37 The floor plane supports the activities inside a space

Fig. 1.38 The floor plane can be manipulated—stepped or terraced
A wall plane can merge with the floor or ceiling or an isolated plane. The distribution of the openings in the walls will determine the quality of space. It can be a neutral backdrop for the other elements in the space. The wall and floor are physically close to the people using the building. The ceiling plane is usually more distant and almost a purely visual element. It can correspond to the form or be the under-surface of the roof or floor plane above, and express its structure. It can also be a detached lining within the space.

Fig. 1.39 A vaulted sky plane, where the ceiling plane merges with the wall plane

As a detached lining, the ceiling plane can be manipulated to symbolize a vaulted sky plane (Fig. 1.39). It can be raised or lowered to alter the scale of a space or to define the zones of the space within a room.

A roof plane, which is the building’s prime sheltering element, protects the interior from climatic elements (Fig. 1.40). The roof can merge with the building’s walls (Fig. 1.41).

Fig. 1.40 Robin House, Chicago, built by Frank Lloyd Wright. The roof plane projects out of the building to protect the openings in the walls from sun or rain.
Ancient megalithic stone structures have been found in burial grounds. They consisted of three vertical stones, which supported the ‘roof’, which was a fourth horizontal slab (Fig. 1.42).

The roof plane has a significant impact on the building’s silhouette. The building’s overall form acquires a planar quality (Fig. 1.43) by differentiating between vertical and horizontal planes, by using different colours, textures, and materials, and by introducing openings between planes and at corners and visually exposing their edges.
A point (or vertex) is formed where several planes meet; a line (or edge) is formed where two planes meet. Planes (or surfaces) define the limits or boundaries of volumes. A form is a primary characteristic of a volume. It is determined by the shapes and interrelationships of the planes that form the boundaries of the volume.

As a three-dimensional element in the vocabulary of architectural design, a volume can be either solid space displayed by mass or void space contained or enclosed within planes (Fig. 1.45).

1.3.4 Volume

A plane extended perpendicular to itself becomes a volume (Fig. 1.44). A plane has only two dimensions, length and width, whereas a volume has three dimensions—length, width, and depth.

All volumes can be analysed to consist of the following:
- points
- lines
- planes

Fig. 1.44 A plane when extended becomes a volume

Fig. 1.45 Building forms defining volumes of space (a) Doric temple
Fig. 1.45 (contd) (b) Villa at Gardens (in France) (built by Le Corbusier)

Fig. 1.45 (contd) (c) Barn (in Ontario, Canada)
Fig. 1.45 (contd) (d) Piazza (in Italy)

Fig. 1.45 (contd) (e) Palazzo (in Italy)
1.4 Understanding the Principles of Design

The principles of design of a building are based on the function/specific purpose and the varied needs of the building. The following ‘ordering principles’ are visual methods that allow the form and space of a building to co-exist in order to make a design complete (Fig. 1.46).

- **axis**
- **symmetry**
- **hierarchy**
- **rhythm/repetition**
- **datum**
- **transformation**

(a) **Axis** A line drawn between two points in space and about which forms and spaces can be arranged in a regular or irregular manner.

(b) **Symmetry** The balanced distribution of equivalent forms and spaces about a common line (axis) or point (centre).

(c) **Hierarchy** The importance or significance of a form or space based on its size, shape, or placement relative to other forms and spaces of the organization.

(d) **Rhythm/repetition** The use of recurring patterns to organize a series of like forms or spaces.

(e) **Datum** A line, plane, or volume that by its continuity and regularity helps to organize a pattern of forms and spaces.

(f) **Transformation** A principle through which an architectural concept or organization can be retained, strengthened, and built upon through a number of manipulations.
1.4.1 Axis

The axis is the most elementary means of organizing forms and spaces (Fig. 1.47). Although imaginary and not visible, an axis is a powerful dominating and regulating device. It helps to establish symmetry and balance.

(a) An axis is a linear condition (line) which has length and direction; it allows for views and movement along its path.

(b) To define an axis, it should be terminated at both ends.
(c) An axis can be established by defining edges along its length. These edges can be simply lines on the ground plan, or vertical planes that define a linear space (Fig. 1.48).
(d) An axis can also be established by a symmetrical arrangement of forms and spaces.

Fig. 1.47 The axis
Fig. 1.48 Edges (buildings) are defined along an axis
The terminating elements of an axis serve to both send and receive its visual thrust. These terminating elements can be any of the following (Fig. 1.49).

(a) **Points** in space, which are (represented) established by vertical or linear elements
(b) **Vertical planes** such as a symmetrical building façade
(c) **Well-defined space**, which can be centralized
(d) **Gateway**, which is open towards a view or vista beyond (Fig. 1.50)

**Fig. 1.50** A row of columns viewed through the entrance arch defines an axis
1.4.2 Symmetry

An axial condition can exist without a symmetrical condition, the converse is not possible. A symmetrical condition requires a balanced arrangement of equivalent patterns of form and space about a common line (axis) or point (centre). There are two types of symmetry (Fig. 1.51):

(a) **Bilateral symmetry** refers to the balanced arrangement of equivalent elements about a common axis.

(b) **Radial symmetry** consists of equivalent elements balanced about two or more axes that intersect at a central point.

![Symmetrical condition diagram](image-url)
Fig. 1.52 A building in Venice, Austria. Two axes can be established about which the arched openings and the elements in the elevation are symmetrical.

Fig. 1.53 Oak Park, Illinois (built by F.L. Wright). A vertical axis can be established.

An architectural composition can utilize symmetry to organize forms and spaces in two ways.

Case 1 Forms and spaces can be organized symmetrically through an entire building (see Figs 1.52 and 1.53).

Case 2 A symmetrical condition can occur only in a portion of the building (Fig. 1.54), and an irregular pattern of forms and spaces can be organized in the rest of the building. This method helps to satisfy site conditions.

Fig. 1.54 A portion of a building that is symmetrical.
1.4.3 Hierarchy

The principle of hierarchy is based on the fact that most architectural buildings have real differences among their forms and spaces. These differences reflect the degree of importance of these forms and spaces (Fig. 1.55). The way in which the functional or symbolic differences among the building elements are shown helps in establishing a visible, hierarchical order among the forms and spaces.

![Fig. 1.55 Principle of hierarchy—the central structure is given more importance by varying its height and structure](image1)

If an organization of a form or space is to be given importance, it must be made visibly unique (Fig. 1.56). This can be done in the following ways (Figs 1.57–1.59).

![Fig. 1.56 Form or space articulated to be visually unique](image2)
(a) A form or space may be shown to dominate an architectural composition by being made significantly smaller or larger than other elements.

(b) Forms and spaces can be made visually dominant or important by clearly differentiating their shapes from the other elements in the composition. A contrast in shape can also be used.

(c) Forms and spaces can be given importance by allocating to them an important location, by terminating a linear sequence or axial organization, and by focusing on the centralized or radial organization.

Fig. 1.57 Form or space can be made visibly unique
Fig. 1.58 Legislative Assembly Building, Capital Complex, Chandigarh (built by LeCorbusier). The roof of the assembly hall dominates by size, shape, and strategic location.
1.4.4 Rhythm or repetition

Rhythm refers to the regular recurrence of lines, shapes, forms or colours. The concept of rhythm is commonly used to organize forms and spaces in architecture.

All building types incorporate elements that are repetitive:
(a) Beams and columns repeat themselves to form repetitive structural bays (Fig. 1.60) and modules of space.
(b) Windows and doors are built into walls at regular intervals to allow light, air, and people to enter its interiors, and to provide various viewpoints to the surrounding landscape.

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Fig. 1.60 Column details: Notre Dame, France. Beams and columns repeat to form structural bays—principle of rhythm.

The elements in a composition can be grouped according to (a) their closeness to one another and (b) the common visual characteristics. Repetition follows these principles to form the composition of the elements. The simplest form of repetition is a linear pattern (Fig. 1.61). Elements need not be perfectly identical to be grouped in a repetitive fashion. They may merely follow a common method, a common denominator, allowing each element to be individually unique yet belong to the same family.

![Diagram of rhythmic repetition](image)

Fig. 1.61 Harmonious recurrence of lines, shapes, or forms
Forms and spaces can be arranged in a repetitive order according to (Fig. 1.62)
- size
- shape
- detail characteristics

Figures 1.63–1.70 illustrate various rhythmic and repetitive patterns.
Fig. 1.64 Cathedral of Salisbury

Fig. 1.65 Dipteral

Fig. 1.66 The Smintheum

Fig. 1.67 The Victorian façade facing a San Francisco street. Observe the repetition of the elevation façade.
Fig. 1.68 View of a villa in Spain. The rhythmic pattern is observed in the form of the buildings.

Fig. 1.69 Studies on the internal façade of a basilica. The repetition of the columns, archways, and windows in the elevation is marked as a, b, c, ...
1.4.5 Datum

A series of elements can be arranged along an axis which serves as a datum. The datum need not be a straight line, it can also be planar or volumetric in form. Given a random organization of dissimilar elements, a datum can organize these elements in the following ways. See Figs 1.71–1.75.

(a) A line can cut through or form a common edge for the pattern. A grid of lines can also help to form a pattern.

(b) A plane can gather the elements beneath it as in (b) or serve as a background and frame the elements in its field.

(c) A volume can collect the pattern within its boundaries as in (d) or organize them along its perimeter as in (e).

Fig. 1.70 Sydney Opera House, Australia (built by John Utson). The roof structure forms a rhythmic pattern.

Fig. 1.71 Ways in which random objects can be united
Fig. 1.72 Temple group, Japan—random patterns of elements are organized.

Fig. 1.73 Arcades unify the facades of houses that face the Town square of Czechoslovakia.
Fig. 1.74 German pavilion in the World Exhibition, Montreal, Canada. The cable structure unifies the varied structures beneath it, through regularity, continuity, and constant pressure.
1.4.6 Transformation

As with any discipline, the study of architecture also involves the study of the past (the history). By studying the history, one learns about the past experiences and achievements of others. The principle of transformation is based on this study. This principle allows a designer to select a standard architectural model whose formal structure and ordering of elements can be transformed, through a series of changes (Fig. 1.76), to respond to the specific condition and context of the design, so that the original design concept can be strengthened and built upon, rather than destroyed. See Figs 1.77–1.80.
Fig. 1.78 George Blossom House, Chicago. Transformation of the Cruciform plan organization by F.L. Wright.

Fig. 1.79 Mill Owner’s Association building, Ahmedabad. Transformation of ramp leading from the road to the elevated entrance of the building by Le Corbusier.
Summary

As civilizations evolved over millions of years, man felt the need not only to derive physical satisfaction from the basic requirements of life—food, shelter, clothing—but also to experience aesthetic pleasure.

Aesthetics can be defined as anything concerned with the appreciation of beauty. Architecture developed as man began to consciously incorporate aesthetic elements into the building activity. Architecture is, thus, essentially a design process, which results in functionally efficient, economically viable, and aesthetically satisfying building. The elements of aesthetics that play an important role in architecture are mass, space, proportion, symmetry, balance, contrast, pattern, and decoration.

The form or architectural design of a building is generated through conceptual visual elements—point, line, plane, and volume. We can better understand these concepts by studying examples from the history of architecture.

History also provides us with examples of the ‘Ordering principles’ of architecture—visual methods that allow the form and space of a building to co-exist and make a design complete. These are axis, symmetry, hierarchy, rhythm or repetition, datum, and transformation.

The next step is to know more about aesthetics, which plays a vital role in the study of architectural concepts. This is discussed in Chapter 2.
*REVIEW QUESTIONS

Draw sketches wherever possible to make the answer more clear.

Part—A (2 marks each)

1. Define architecture.
2. What is the difference between civil engineering and architecture?
3. Discuss the term aesthetic pleasure.
4. What is form?
5. Define space.
6. Define aesthetics.
7. What do you understand by planning?
8. What is designing?
10. How is erecting done?
11. What do you mean by constructing?
12. What is executing?
13. Define the basic elements of design.
14. Define the following terms with respect to architecture.
   (a) Point
   (b) Line
   (c) Plane
   (d) Volume
15. What are the principles of design?
16. What are the basic principles of architecture?
17. What is an axis?
18. What do you mean by symmetry?
19. What is the difference between radial and bilateral symmetry?
20. What is hierarchy?
21. Define rhythm or repetition.
22. What is datum?
23. What do you understand by transformation?

Part—B (16 marks each)

1. Write short notes on the following
   • Aesthetics
   • Planning
   • Designing
   • Erecting
   • Constructing
   • Executing
2. What do you understand by the basic elements of architecture (or) basic elements of design?
3. Describe in detail the principles used in architecture or in designing.

*Note: According to the Anna University examination pattern, there are ten 2-mark questions, which are compulsory, and five 16-mark questions. Model question papers are given in the Appendix.