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Introduction

As the name of this section suggests, it is meant for to recap the maximum part of the syllabus in minimum possible time. This is a part of GATE ARCHITECTURE 2022 complete set. It covers through short notes on different topics of the syllabus.

There is no limit on the discussion on the topic on General Aptitude. Scoring marks in this section depend on the intuition, clicks etc of the aspirants in the examination hall. However we have included ample examples with answer on Verbal Ability & Numerical Ability topic.

When it comes to the building services, it is essentially an engineering section. Even its topics (for example HVAC or Fire Fighting) comes from different departments. To solve a numerical from a particular topic, we need to understand the concept & theories behind it and knowledge of SI unit conversion to arrive at the precise answer. Here we have tried to introduce the topic through solved examples and derivation theories.

Contents

Section 2: Building Materials, Construction and Management

Behavioral characteristics and applications of different building materials

Timber

Introduction: The Mechanical properties and availability of wood have made it a natural material for building structures, furniture, tools, vehicles, and decorative objects. Worldwide it is used more than metal or plastic.

Wood is a natural product and when used responsibly is a sustainable resource which need not result in damage to the environment. Forests can be protected by recycling and reusing the wood, using less wood and by supporting sustainable forest management

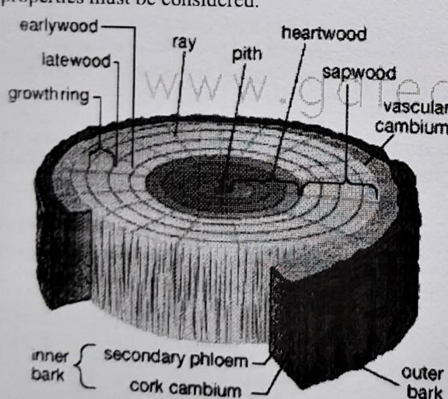
All wood is composed of cellulose, lignin, hemicelluloses, and minor amounts (5% to 10%) of extraneous materials contained in a cellular structure.

Wood comprises about 50% of cellulose which responsible for most of its mechanical properties.

Natural wood is generally composed of bundles of long fibres which are effectively water carrying tubes. These fibres are laid in the direction of the tree trunk or branch from which the wood is removed.

The strength of wood is highly dependent on the loading direction. Wood is strongest in tension along the fibres and is weakest in the radial and tangential direction. When loaded in its strongest direction (longitudinal along the grain - see figure below) wood can have a strength to weight ratio advantage relative to steel of 2:1. However when wood is loaded in other directions (radial and tangential to the grain- see figure below) this advantage disappears

To use wood to its best advantage and most effectively in engineering applications, specific characteristics or physical properties must be considered.



Softwoods are one of the botanical groups of trees that has persistent needle-like or scale-like leaves; softwoods are evergreen and have longer-length fibers than hardwoods.

Softwood trees include pines, spruces, firs , cedars.

Hardwood trees are generally broadleaved trees. These tree species are deciduous, retaining their leaves only one growing season. The designation Hardwood trees does not necessarily relate to the hardness of the wood.. Hardwood trees are also called broad leaf trees or deciduous trees.

Typical hardwood trees include ash, elms, oak, maple, walnut, hickory, mahogany, and walnut. Woods grown in tropical climates are generally hardwoods. Hardwood have shorter fibers compared to softwood. some hardwoods are evergreen.

compression in the tree when it was young. Upset is an injury by crushing. This is also known as rupture.

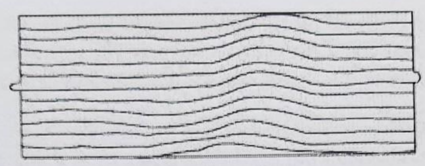


Figure: A typical **upset** in a Timber

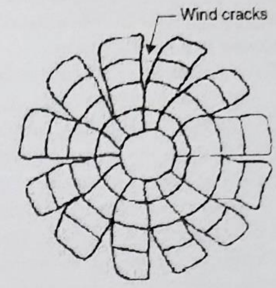


Figure: Wind crakes

(ii) Defects due to Defective Seasoning and Conversion: If seasoning is not uniform, the converted timber may warp and twist in various directions. Sometimes honey combining and even cracks appear. This type of defects are more susceptible in case of kiln seasoning.
In the process of converting timber to commercial sizes and shapes the following types of defects are likely to airse: chip marks, torn grain etc.

(iii) Defects due to Fungi and Insects Attack: Fungi are minute microscopic plant organism.
They grow in wood if moisture content is more than 20°C and exposed to air. Due to fungi attack rotting of wood, takes place. Wood becomes weak and stains appear on it.
Beetles, marine borers and termites (white ants) are the insects which eat wood and weaken the timber. Some woods like teak have chemicals in their compositions and resist such attacks. Other woods are to be protected by chemical treatment.(Source: http://www.civilengineeringx.com/traditional-materials/defects-in-timber/)

Seasoning

This is a process by which moisture content in a freshly cut tree is reduced to a suitable level. By doing so the durability of timber is increased. The various methods of seasoning used may be classified into:
(i) Natural seasoning
(ii) Artificial seasoning.

(i) Natural Seasoning: It may be air seasoning or water seasoning. Air seasoning is carried out in a shed with a platform. On about 300 mm high platform timber balks are stacked as shown in Fig. 1.8.
Care is taken to see that there is proper air circulation around each timber balk. Over a period, in a natural process moisture content reduces. A well seasoned timber contains only 15% moisture. This is a slow but a good process of seasoning.
Water seasoning is carried out on the banks of rivers. The thicker end of the timber is kept pointing upstream side. After a period of 2 to 4 weeks the timber is taken out. During this period sap contained in the timber is washed out to a great extent. Then timber is stalked in a shed with free air circulation.

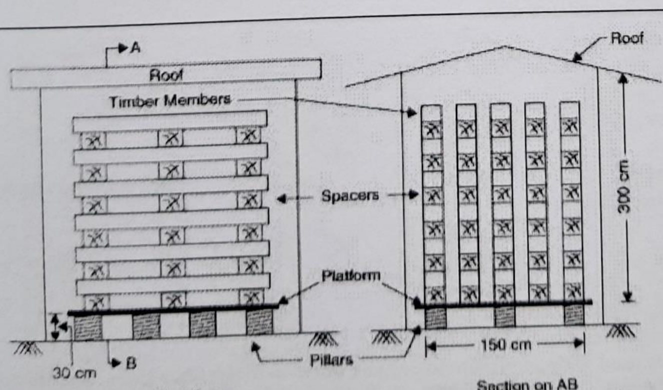


Figure: Air Seasoning

(ii) Artificial Seasoning: In this method timber is seasoned in a chamber with regulated heat, controlled humidity and proper air circulation. Seasoning can be completed in 4 to 5 days only. The different methods of seasoning are:
(a) Boiling
(b) Kiln seasoning
(c) Chemical seasoning
(d) Electrical seasoning.

9. Babul, Eucalyptus, poplar, sissioo (20 yrs).
10. A single tree can cool the summer heat for an entire day and night and is found better than 20 ACs running for 20 Hrs.
11. A hectare of trees produce about 10 times of O2 (for 45 persons for 1 year)

Item	Soft wood	Hard wood
Annual rings	Distinct	Opposite
Color	Light	"
Fire resistance	Poor	"
Modular rays	Indistinct	"
Strength	Strong for direct pull and weak for resisting thrust or shear	"
Structure	Resinous and split easily	"
Weight	Light	"

12. Defects in timber
    a. Conversion
    b. Fungi
    c. Insects
    d. Natural forces
    e. Seasoning

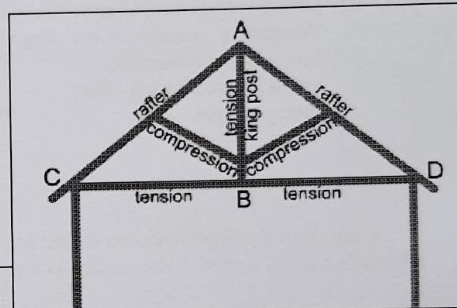


Figure: Typical forces on King post

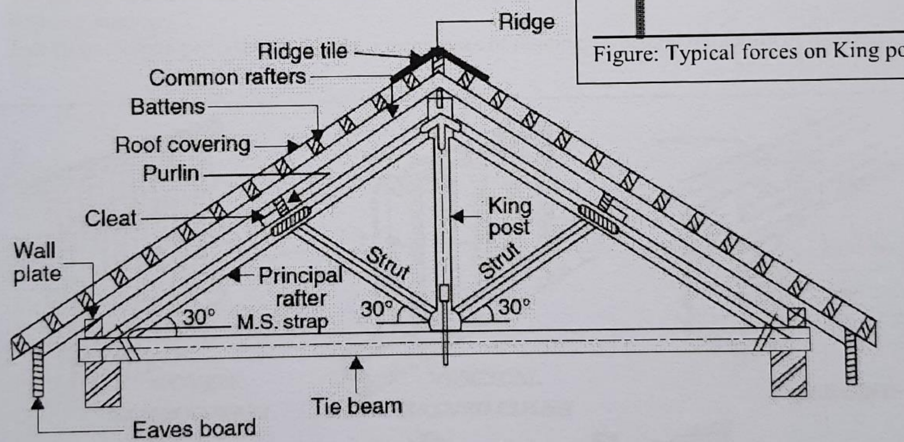


Figure: Typical wooden truss (King post)

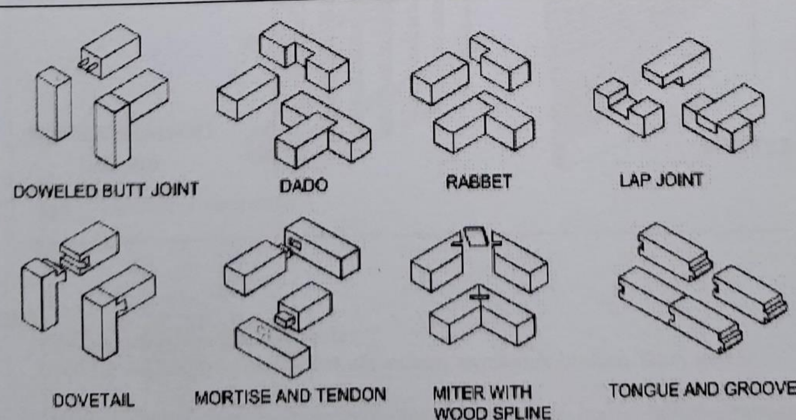


Figure: Types of Joints

RAFT or MAT FOUNDATIONS

A raft foundation, also called a mat foundation, is essentially a continuous slab resting on the soil that extends over the entire footprint of the building, thereby supporting the building and transferring its weight to the ground.

A raft foundation is often used when the soil is weak, as it distributes the weight of the building over the entire area of the building, and not over smaller zones (like individual footings) or at individual points (like pile foundations). This reduces the *stress* on the soil.

The concept of stress is very basic to civil engineering. Stress is simply weight divided by area. For example, if a building measuring 5 x 5 weighs 50 tons, and has a raft foundation, then the stress on the soil is weight / area = 50/25 = 2 tons per square meter.

If the same building were supported by say 4 individual footings, each of 1 x 1m, then the total area of the foundation would be 4 m2, and the stress on the soil would be 50/16, which is about 12.5 tons per square meter. So increasing the total area of the foundation can dramatically lower the stress on the soil, which is nothing but weight per square meter.

A raft foundation is also very good for basements. Foundations are created by excavating soil in order to find strong, compact, undisturbed natural soil that is at least a few feet below ground level. This soil is much stronger than the loose soil at the surface. If we construct a raft foundation at say 10 feet below ground, and build concrete walls around the periphery, this makes an excellent basement. Therefore, an engineer designing a building with a basement will tend to choose a raft foundation over other types of foundations.

How to construct a raft or mat foundation

A raft foundation is constructed by first excavating the ground to a uniform, flat level.

Then, a waterproof plastic sheet is laid over the earth, and a thin 3" layer of plain cement concrete (PCC) is poured just to create a perfectly flat and level base for the foundation.

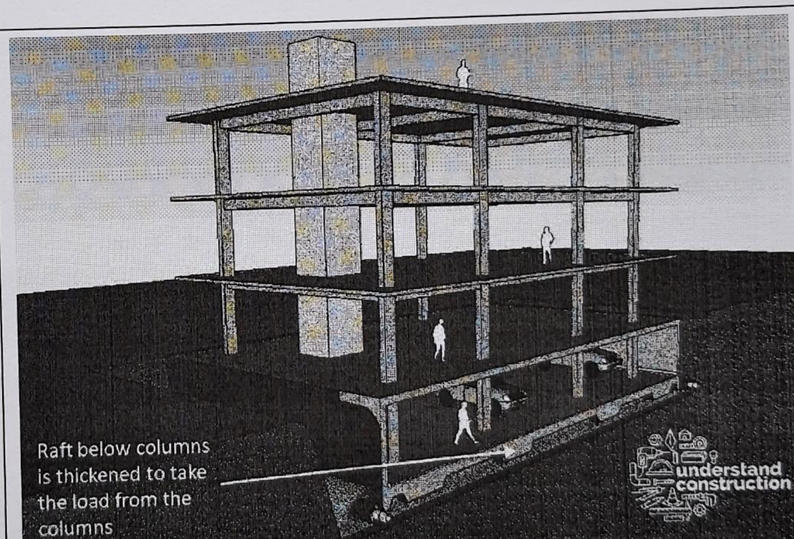


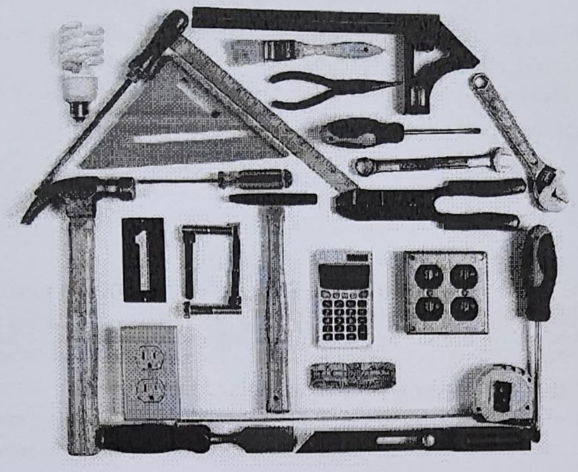
Figure: Raft foundation

After this, a waterproofing layer is installed, and then reinforcement steel for the raft slab is tied in place. After all the steel has been put in place, concrete is poured to the desired thickness, which is usually in the range of 200mm (8") to 300mm (12") thick for small buildings: this can be much thicker if heavy loads are to be carried.

Waterproofing of basements

Basements often extend several stories below ground. The soil or rock around the basement can easily be saturated with water. This water will seep into the building if the building is not waterproofed properly, as concrete is not impermeable to water (it allows water to pass through). So engineers pay a great deal of attention to the waterproofing design of basements, as once this is done, there is no way to repair it, so it must be done perfectly during construction.

The best way to do this is to wrap the outside of the basement in a waterproof layer called a waterproofing membrane. This should cover the bottom and all sides of the basement, and should be placed between the soil and the concrete, so that the concrete always remains dry. The waterproofing membrane must also be physically strong, as the raft will be constructed on top of it, and the weight of the building will press down on it. This layer also serves to chemically



Introduction to Building Services

GATE Syllabus related to Building Services: Water supply; Sewerage and drainage systems; Sanitary fittings and fixtures; Plumbing systems; Principles of internal and external drainage system; Principles of electrification of buildings; Intelligent Buildings; Elevators and Escalators - standards and uses; Air-Conditioning systems; Firefighting Systems; Building Safety and Security systems.

Contents

This study manual is prepared from different source books & references on advance level building services. It's been trimmed down to restrict around GATE syllabus. However to maintain the coverage of topic, some discussions may have exceeded the syllabus. The aim of this manual is to introduce the concept of derivations and basic engineering.

Some topics on building services that may not be discussed here are better discussed in question-bank. You are suggested to read this section along question-bank as complementary.

Thus the overall value of U is given by:
$U = (0.97*1.8) + (0.03*2.54)\ \text{W/m}^2\text{K} = 1.82\ \text{W/m}^2\text{K}$

The thermal transmittance of windows depends on glazing and frame types and exposure. If a low-emissivity reflective metallic film is applied to the inside surface of the glass, then the internal surface resistance value can be significantly increased, resulting in a lower U value and reduced heat and light transmission from outside. Glass and metal window frames, in themselves, offer negligible resistance to heat flow, but when resistive materials are used the overall U value can be found using the proportional area method.

Heat loss from buildings

Heat loss occurs by convection and radiation from the outside of the building, and by infiltration of outdoor air. Heating equipment is sized on the basis of steady-state heat flows through the building fabric, with an estimation of the effect of non-steady influences relating to the thermal storage capacity of the structure, adventitious heat gains from people, lighting and machines, and the intermittency of heating system operation.

The steady-state heat loss Q_u through the building fabric is:

$$Q_u = \sum (AU)(t_{ei} - t_{ao})\ \text{W}$$

Where $\Sigma(AU)$ is the sum of the products of the area and thermal transmittance of each room surface. Heat flows to adjacent rooms that are warmer than the outdoor air are found by using the appropriate temperature difference between them.

The ventilation heat Q_v required to warm the natural infiltration of outdoor air is:

$$Q_v = 0.33\ NV\ (t_{ai} - t_{ao})\ \text{W}$$

The total heat requirement for each room is:

$$Q_p = Q_u + Q_v$$

The values of environmental and air temperature used in the calculations depend upon the type of heating system employed, and the following temperature ratios are used:

$$F_1 = \frac{t_{ei} - t_{ao}}{t_c - t_{ao}}$$

$$F_2 = \frac{t_{ai} - t_{ao}}{t_c - t_{ao}}$$

These two ratios are substituted into the equations for heat requirements Q_u and Q_v. The total heat requirement Q_p then becomes:

$$Q_p = \left[F_1 \sum (AU) + 0.33 F_2 NV\right] (t_c - t_{ao})\ \text{W}$$

For buildings with average external U values in the range 0.60–3.0 W/m²K, including openings, which covers the majority of habitable structures, the temperature ratios have the following values (with an accuracy to 5.0%):

$F_1 = 1.00 \quad F_2 = 1.10$

For panel radiator heating systems:
$F_1 = 0.92 \quad F_2 = 1.23$

For forced warm-air heating systems. Further values are tabulated in the *CIBSE Guide*. To check the comfort conditions produced by the heating system in a room we use:

Circuit design

The resistance R ohms (K) of an electrical conductor depends on its specific resistance ρ Km, its length l m and its cross-sectional area A m^2. The specific resistance of annealed copper is 0.0172 μKm (μ, micro stands for 10^{-6}) at 20°C.

$$R = \rho \frac{l}{A} \Omega$$

Example 6.1

Calculate the electrical resistance per metre length at 20°c of a copper conductor of 2.5 mm^2 cross-sectional area.

$$K = \frac{0.0172}{10^6} Km \times \frac{1\,m}{2.5\,mm^2} \times \frac{10^6\,mm^2}{1\,m^2}$$

$$= 0.0069\,K$$

The resistance of a cable increases with increase in temperature and the temperature coeffi- cient of resistance (α) of copper is 0.00428 K/K°C at 0°C. If the resistance of the conductor is R_0 at 0°C, then its resistance at another temperature R_t can be found from:

$$R_t = R_0\,(1 + \alpha t)\;K$$

where t is the conductor temperature (°C).

Example 6.2

Find the resistance of a 2.5 mm^2 copper conductor at 40°c.

R_0 is not known but the resistance of this conductor at 20°C was found in Example 13.1 and t can represent the increase in temperature above this value. A graph of resistance versus temperature would reveal a straight line of slope α.

$$R_{40} = R_{20}\,(1 + \alpha \times 20)\;K$$

$$= 0.0069 \times (1 + 0.00428 \times 20)\;K$$

$$= 0.0075\;K$$

The relation between applied voltage, electric current and resistance is given by Ohm's law:

$$I \text{ amps} = \frac{V \text{ volts}}{R \text{ ohms}}$$

The load may be an electrical resistance heater or tungsten filament lamp, in which case the power consumption in watts is found from:

power in watts = V volts × A amps × cos φ

Sound power and pressure levels

Sound power and pressure levels are measured over a range of frequencies that are representative of the response of the human ear to sounds. The unit of measurement of sound is the Bel (B). The smallest increment of sound that the human ear can detect is one-tenth of a Bel, one decibel (dB). This means that the smallest change in sound level that is perceptible by the human ear is 1 dB, so any decimal places that are produced from calculations using sound power or pressure level are not relevant. A calculated sound level of 84.86 can only be 84 dB as the 0.86 decimal portion is not detectable by the ear. The 'A' scale of measurement gives a weighting to each frequency in the range 20 Hz to 20 kHz in the same ratio as can be heard. For example, the human ear is more sensitive to sounds at 1000 Hz than at higher frequencies.

The acoustic output power of a machine is termed its sound power level, *SWL* dB. Think of *SWL* as the sound watts level of the acoustic output power of the machine. The value of acoustic power in watts from building services plant is very small, much less than 1 watt of power. The word level is used because it is not the actual value of the number of watts that is normally used; it is the sound level produced in acoustic units of measurement, dB, that are taken for practical use. The manufacturer of the plant provides the sound power levels produced by a particular machine from test results and predictions for known ranges of similar equipment. The sound power level of a machine at the range of frequencies from 125 to 8000 Hz is required by the building services design engineer in order to assess the acoustic affects upon the occupied spaces of the building. The overall sound power level for a range of frequencies is also quoted by the manufacturer of a machine.

Sound pressure level

A sound field is created by the sound power output from a machine within a plant room. It is made up of a direct sound field, that is, directly radiated sound, and a reverberant sound field, that is, general sound that reflects uniformly from the hard surfaces around the room. The direct sound field reduces with the inverse square of the distance from the sound source and is not normally of importance as it only applies to very short distances from the sound source. The reverberant sound field results from the average value of the sound pressure waves passing around the room. These waves try to escape from the plant room and find their way into the occupied spaces where the air-conditioning engineer is attempting to create a quiet and comfortable environment. The sound pressure level, *SPL* dB, of the total sound field, direct plus reverberant, that is generated within a room from a sound source of sound power level *SWL* dB, is found from

$$SPL = SWL + 10 \times \log\left(\frac{Q}{4 \times \pi \times r^2} + \frac{4}{R}\right) \text{ dB}$$

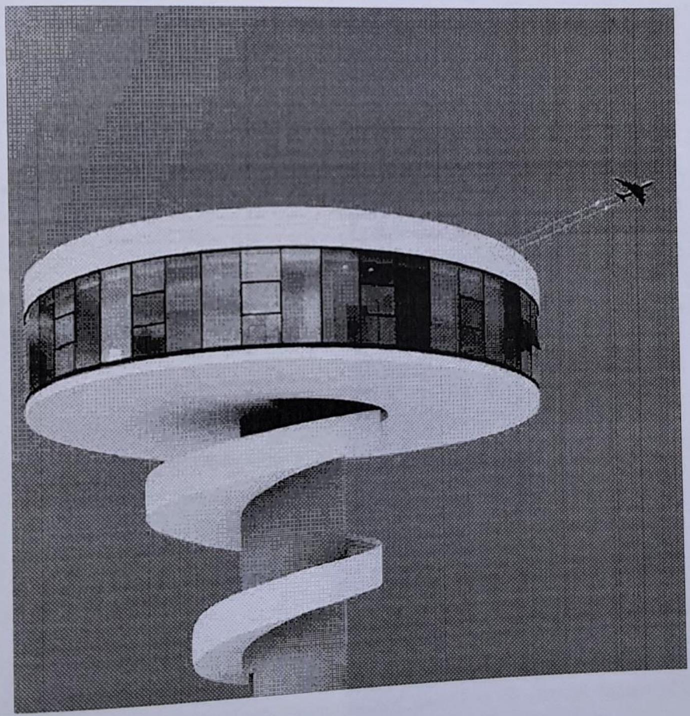
where,

SPL = sound pressure level produced in room dB
SWL = sound power level of acoustic source dB
log = logarithm to base 10 dimensionless
Q = geometric directivity factor dimensionless
r = distance from sound source to the receiver m
R = room sound absorption constant m^2

Logarithms to base 10, log10, are used throughout the calculation of acoustic values. A sound source that radiates sound waves uniformly in all directions through unobstructed space will create an expanding spherical sound field and have a dimensionless geometric directionality factor Q of 1. A sound source that is on a plane surface radiates all its sound energy into a hemispherical sound field moving away from the surface. This has a directionality factor Q of 2, that is, twice the sound energy passes through a hemisphere. Similarly, if the sound source occurs at the junction of two adjacent surfaces that are at right angles to each other, such as the junction of a wall and ceiling, Q is 4. When there are three adjacent surfaces at the

Sound level meter device.

BEAM MECHANICS



For B.M diagram:

If we just take the moments to the left of the cross-section,

$$B.M_{X-X} = \frac{W}{2}x \text{ for } x \text{ lies between } 0 \text{ and } l/2$$

$$B.M_{\text{at } x = \frac{l}{2}} = \frac{W}{2}\frac{l}{2} \text{ i.e B.M at } x = 0$$

$$= \frac{Wl}{4}$$

$$B.M_{Y-Y} = \frac{W}{2}x - W\left(x - \frac{l}{2}\right)$$

Again

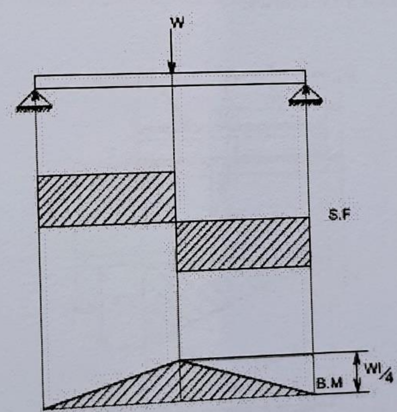
$$= \frac{W}{2}x - Wx + \frac{Wl}{2}$$

$$= -\frac{W}{2}x + \frac{Wl}{2}$$

$$B.M_{\text{at } x = l} = -\frac{Wl}{2} + \frac{Wl}{2}$$

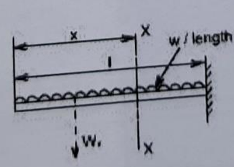
$$= 0$$

Which when plotted will give a straight relation i.e.



It may be observed that at the point of application of load there is an abrupt change in the shear force, at this point the B.M is maximum.

3. A cantilever beam subjected to U.d.L, draw S.F and B.M diagram.

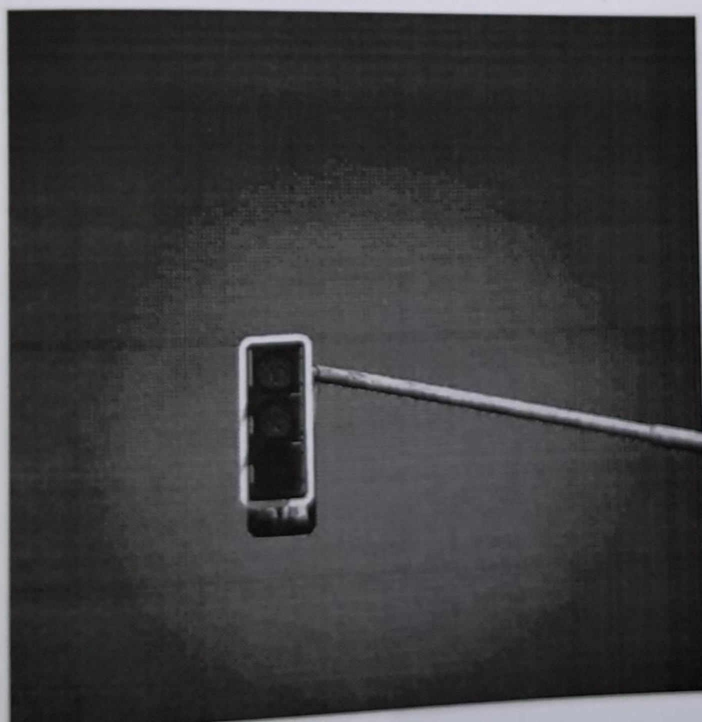


Here the cantilever beam is subjected to a uniformly distributed load whose intensity is given w / length.

Consider any cross-section XX which is at a distance of x from the free end. If we just take the resultant of all the forces on the left of the X-section, then

$S.F_{xx} = -Wx$ for all values of 'x'. ---------- **(1)**

GENERAL APTITUDE



Directions to Solve

Find the statement that must be true according to the given information.

1. Vincent has a paper route. Each morning, he delivers 37 newspapers to customers in his neighborhood. It takes Vincent 50 minutes to deliver all the papers. If Vincent is sick or has other plans, his friend Thomas, who lives on the same street, will sometimes deliver the papers for him.

A. Vincent and Thomas live in the same neighborhood.
B. It takes Thomas more than 50 minutes to deliver the papers.
C. It is dark outside when Vincent begins his deliveries.
D. Thomas would like to have his own paper route.

Answer: Option **A**
Explanation: The fact that Vincent and Thomas live on the same street indicates that they live in the same neighborhood. There is no support for any of the other choices.

2. The Pacific yew is an evergreen tree that grows in the Pacific Northwest. The Pacific yew has a fleshy, poisonous fruit. Recently, taxol, a substance found in the bark of the Pacific yew, was discovered to be a promising new anticancer drug.
A. Taxol is poisonous when taken by healthy people.
B. Taxol has cured people from various diseases.
C. People should not eat the fruit of the Pacific yew.
D. The Pacific yew was considered worthless until taxol was discovered.

Answer: Option **C**
Explanation: Given the information presented, the only statement that could be considered true is that the fruit should not be eaten because it is poisonous. There is no support that taxol is poisonous or that taxol has cured anyone (choices a and b). There is no support for choice d.

3. Erin is twelve years old. For three years, she has been asking her parents for a dog. Her parents have told her that they believe a dog would not be happy in an apartment, but they have given her permission to have a bird. Erin has not yet decided what kind of bird she would like to have.

A. Erin's parents like birds better than they like dogs.
B. Erin does not like birds.
C. Erin and her parents live in an apartment.
D. Erin and her parents would like to move.

Answer: Option **C**
Explanation: Since Erin's parents think a dog would not be happy in an apartment, we can reasonably conclude that the family lives in an apartment. We do not know if Erin's parents dislike dogs (choice a) or if Erin dislikes birds (choice b). There is no support for choice d.

4. Tim's commute never bothered him because there were always seats available on the train and he was able to spend his 40 minutes comfortably reading the newspaper or catching up on paperwork. Ever since the train schedule changed, the train has been extremely crowded, and by the time the doors open at his station, there isn't a seat to be found.
A. Tim would be better off taking the bus to work.
B. Tim's commute is less comfortable since the train schedule changed.
C. Many commuters will complain about the new train schedule.
D. Tim will likely look for a new job closer to home.

Answer: Option **B**
Explanation: The passage tells us that Tim's commute didn't bother him because he was always able to sit down and comfortably read or do paperwork. Therefore, it is reasonable to assume that Tim's commute has become less comfortable since the schedule change, because it is very crowded and he can no longer find a seat. There is no information given that supports choices a, c, and d.

5. When they heard news of the hurricane, Maya and Julian decided to change their vacation plans. Instead of traveling to the island beach resort, they booked a room at a fancy new spa in the mountains. Their plans were a bit more expensive, but they'd heard wonderful things about the spa and they were relieved to find availability on such short notice.

ARCHITECTS WORK

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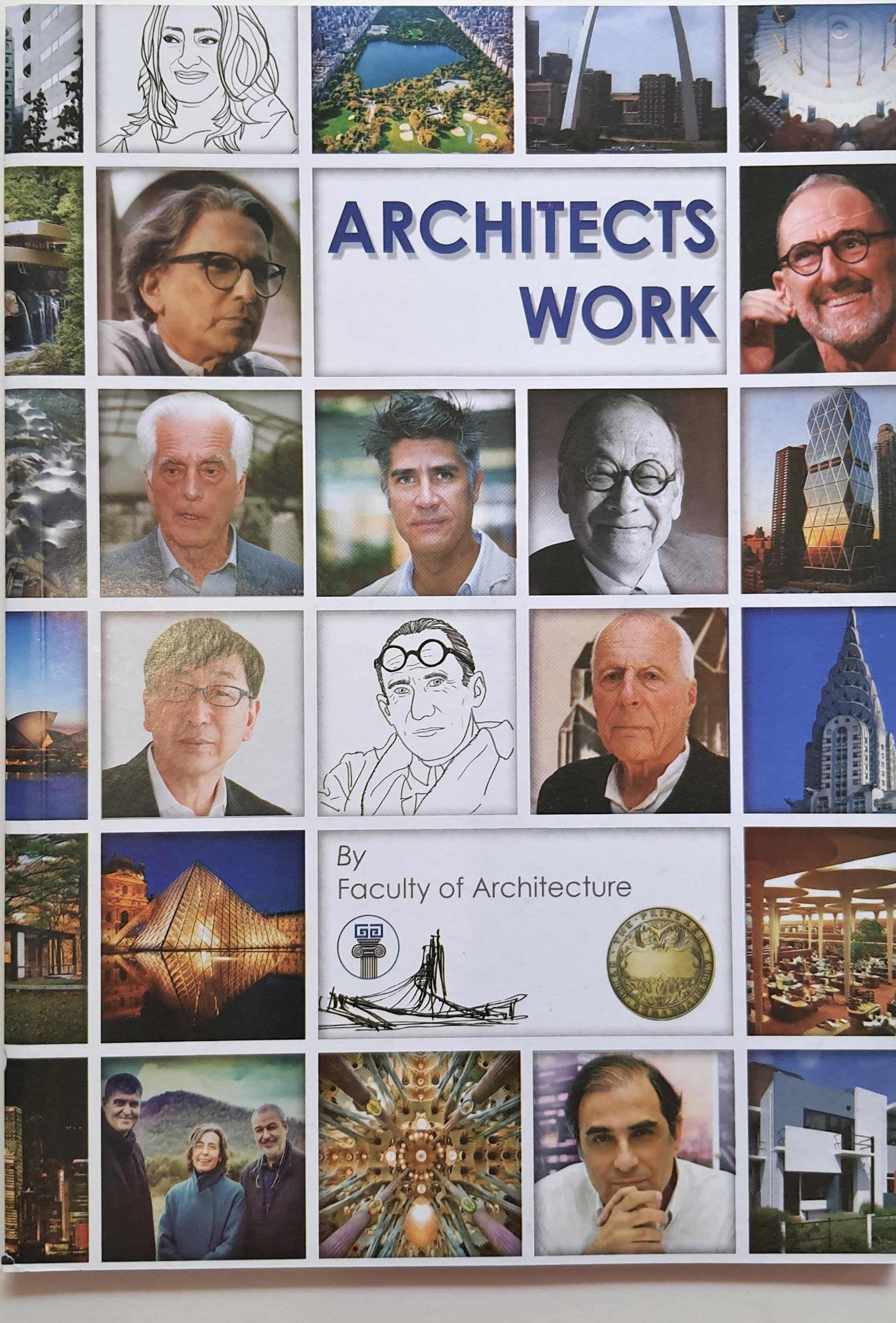


Pritzker Prize

To honor a **living architect** or architects whose built work demonstrates a combination of those qualities of talent, vision, and commitment, which has produced consistent and significant contributions to humanity and the built environment through the art of architecture. The award consists of $100,000 (US) and a bronze medallion.

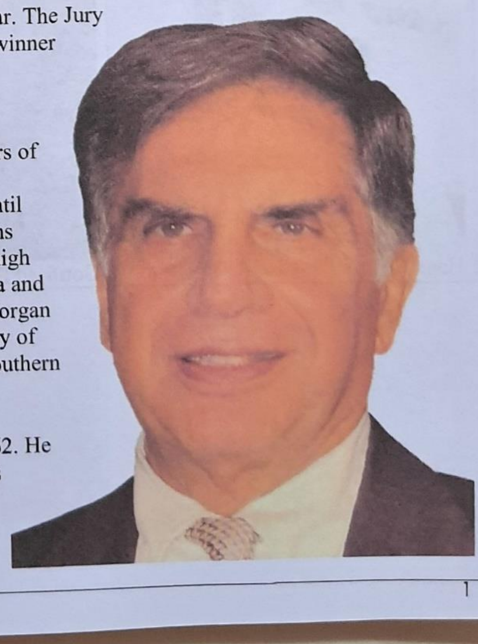
Figure: Medal of the Pritzker Architecture Prize (Front & Back)

The international prize, which is awarded each year to a living architect/s for significant achievement, was established by the Pritzker family of Chicago through their Hyatt Foundation in 1979. It is granted annually and is often referred to as "architecture's Nobel" and "the profession's highest honor."

How to nominate?
The Pritzker Architecture Prize does not discriminate on the basis of race, color, religion, national origin, sex, disability, or age in its programs and activities. The prize is awarded irrespective of nationality, race, creed, or ideology. Nominations are accepted internationally from persons of diverse fields who have a knowledge of and interest in advancing great architecture.

The Executive Director actively solicits nominations from past laureates, architects, academics, critics, politicians, professionals involved in cultural endeavors, and persons of diverse fields who have an expertise and interest in the field of architecture.

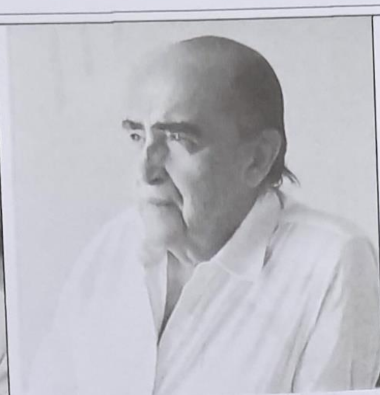
Additionally, any licensed architect may submit a nomination to the Executive Director for consideration by the jury for the Pritzker Architecture Prize. Nominations are accepted through November 1 of any given year. It is sufficient to send an e-mail to the Executive Director with the nominee's name and contact information. Nominations that do not result in the award are automatically carried over to the following year. The Jury normally undertakes deliberations early in the calendar year and the winner is announced in the spring. For more info, visit: https://www.pritzkerprize.com



Jury Members: ***Ratan N. Tata*** from India is one of the jury members of Pritzker Prize. He is also the Chairman Emeritus of Tata Sons, the holding company of the Tata Group. He was Chairman from 1991 until his retirement in 2012. He was responsible for transforming Tata Sons into a group strategy think-tank, and a promoter of new ventures in high technology businesses. Tata serves on the board of directors of Alcoa and on the international advisory boards of Mitsubishi Corporation, JPMorgan Chase, Rolls-Royce, Temasek Holdings, and the Monetary Authority of Singapore. He serves on the board of trustees of the University of Southern California and Cornell University.

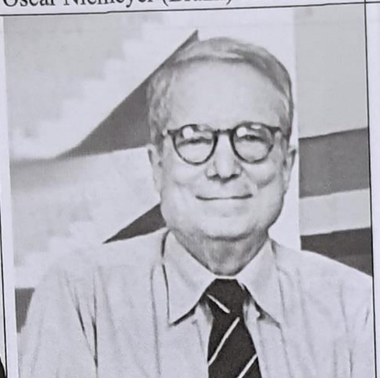
Tata received a Bachelor of Architecture degree from Cornell in 1962. He completed the Advanced Management Program at Harvard Business School in 1975. Tata is the Chairman of two of the largest philanthropic trusts in India and has received numerous international honors for his philanthropy. Through Tata Group's

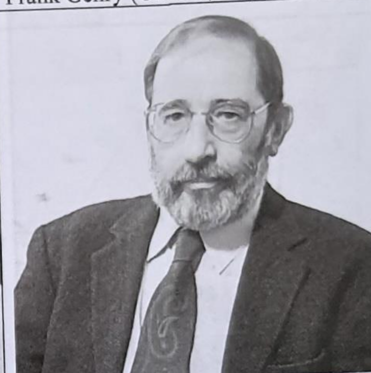

Gordon Bunshaft (US) 1988

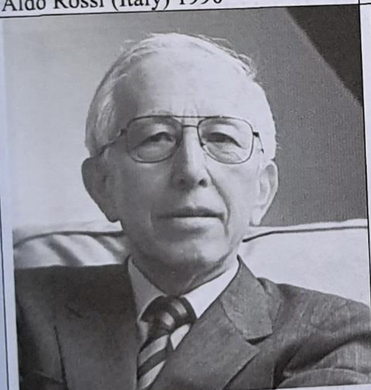

Oscar Niemeyer (Brazil) 1988

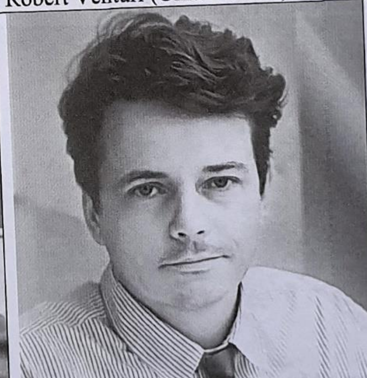

Frank Gehry (Canada, US) 1989


Aldo Rossi (Italy) 1990


Robert Venturi (United States) 1991

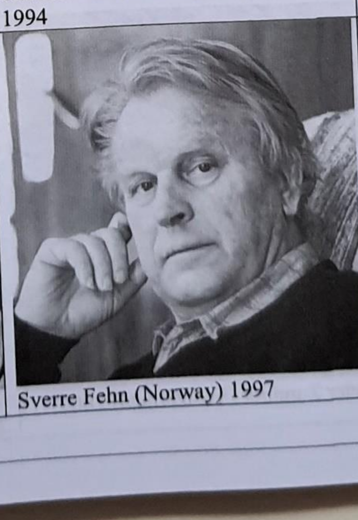

Álvaro Siza Vieira (Portugal) 1992


Fumihiko Maki (Japan) 1993


Christian de Portzamparc (France) 1994


Tadao Ando (Japan) 1995


Rafael Moneo (Spain) 1996


Sverre Fehn (Norway) 1997


Renzo Piano (Italy) 1998

1979)

for his unconventional de
kel and to the modernism o

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rganizing of volumes. These a
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ontains, cuddles, exalts, or

itself around you.

on became the first Director of
nd 1945-1954). He coined the
Ludwig Mies van der Rohe and
s considered the most superb

Breuer. For his master degree
hich has been called one of the

Figure: The Glass House, 1949

The **Glass House** is best understood as a pavilion for viewing the surrounding landscape. Invisible from the road, the house sits on a promontory overlooking a pond with views towards the woods beyond. The house is 55 feet long and 33 feet wide, with 1,815 square feet. Each of the four exterior walls is punctuated by a centrally located glass door that opens onto the landscape. The house, which ushered the International Style into residential American architecture, is iconic because of its innovative use of materials and its seamless integration into the landscape.

http://theglasshouse.org/explore/the-glass-house/

Figure: The Seagram Building, New York

The Seagram Building is a modern office tower designed by famed German architect Mies van der Rohe, in collaboration with Philip Johnson. Mies believed that "less is more" and that "God is in the details." Both of these tenets are in evidence (and occasionally in contradiction) in his sleek, modern Seagram Building – an avant-garde statement when it was completed in 1958.

Flaunting its glass and metal, and foregoing the heavy stone and brick used in ornamental facades of previous decades, the Seagram Building helped usher in a new era of simple, straightforward skyscrapers – buildings that embraced and celebrated their structures and minimalist geometries, rather than camouflaging them with superfluous ornament and detail.

Concept: Symbol of contemporary industrial world, illustrates the architect's motto "Less is more" showing that a simple building can be just as surprising that a building with more composite designs. The Seagram Building is a refined synthesis of rationalist architecture in which Mies had formed, the international style that was beginning to dawn on architecture since 1950 and the contributions of the Chicago school.

https://interactive.wttw.com/tenbuildings/seagram-building
https://en.wikiarquitectura.com/building/seagram-building/

Figure: Crystal Cathedral, Garden Grove, CA

The Crystal Cathedral was designed as a religious theater of sorts, acting as both television studio and stage to a congregation of 3,000. Philip Johnson and John Burgee devised the glass enclosure so that that the church be open to the "sky and the surrounding world."

The single, gigantic space measures 400 feet by 200 feet in length and width. The design is a modification of the typical Latin cross plan, with a shortened nave and widened transept, to bring each seat closer to the chancel. In a nod to Los Angeles car culture, the parking lot was designed for a drive-in congregation to listen to the sermon via car stereo. 90-foot-high doors beside the chancel open onto the parking lot, providing ventilation and a visual connection between attendees.

https://www.archdaily.com/445618/ad-classics-the-crystal-cathedral-philip-johnson

os Angeles.

e women—four of wh
esting that he rememb
aviour.

The city Hague (Netherland) **has unveiled the world's largest mondrian painting on the façade of richard meier's iconic architectural landmark, city hall.** familiar red, yellow and blue surfaces and straight lines wrap the mega-structure, forming a totally unique composition that blends the building's architectural facets with precisely-painted blocks of color. the hague municipal council's decision to honor the world renowned artist through this outdoor exhibition heralds the start of a themed year coined 'mondrian to dutch design'.
https://www.designboom.com/art/richard-meier-mondrian-city-hall-the-hague-02-15-2017/

Figure: Known informally as the **Jubilee Church**, the Church of God the Merciful Father in Rome was completed in 2003 with distinctive walls that gently curve toward the building's center. Designed to reflect sunlight to regulate the structure's internal temperature, the concrete walls contain titanium dioxide that not only keeps them pristine white but also reacts with UV rays to break down air pollutants.

Figure: Rome's Museum of the Ara Pacis, completed in 2006, contains the namesake altar of Augustus, built in dedication to Pax, the Roman goddess of peace. Made using steel, travertine, and glass, the building also features exhibition space, a digital library, a café, and rooftop terrace.
https://www.architecturaldigest.com/gallery/richard-meier-architecture/all

Figure: Opened to the public in 1995, the Barcelona Museum of Contemporary Art was referred to as the Pearl by the city's news media because of its luminous exterior of concrete and white enamel-coated steel. With a three-story atrium and smooth geometry, the structure, designed in homage to the modernist architectural movement, stands in stark contrast to the Gothic buildings in the area" or similar.

Frank Gehry (Canada, US) (Pritzker Prize 1989)

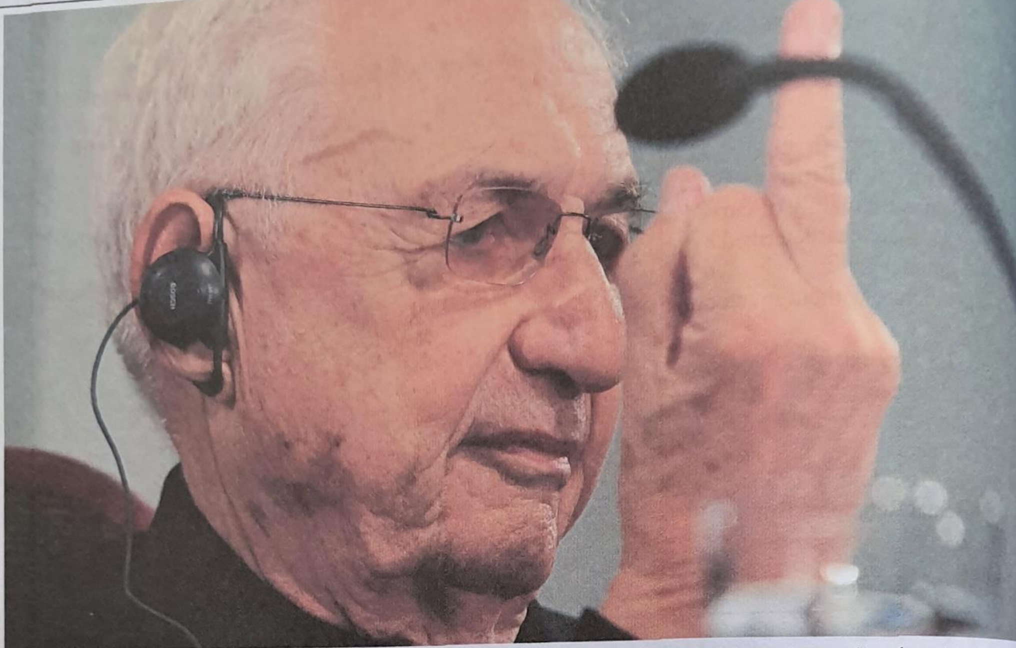

Figure: Frank Gehry has described 98% of modern architecture as "shit" and given a journalist the middle finger salute at a press conference. Gehry was in Oviedo, Spain to collect the Prince of Asturias prize. 2014.

Photograph: J I Cereijido/EPA Source: https://www.theguardian.com/artanddesign/2014/oct/24/frank-gehry-journalist-finger-architecture-shit

Buildings by Frank Gehry: From his earliest works, architect Frank Gehry has shattered conventions, designing buildings that some critics say are more sculpture than architecture. Using unorthodox materials like corrugated metal and chain link, Gehry creates unexpected, twisted forms. His work has been called radical, playful, organic, and sensual.

 Guggenheim Bilbao by Architect Frank Gehry	 Walt Disney Concert Hall, Los Angeles, CA	 IAC Building by Architect Frank Gehry	 Maggies Centre by Architect Frank Gehry
 'MARTa' Museum by Architect Frank Gehry	 Jay Pritzker Music Pavillion by Architect Frank Gehry	 Ray and Maria Stata Center by Architect Frank Gehry	 Weisman Art Museum by Architect Frank Gehry
 Fisher Center for the Performing Arts	 Gehry House by Frank Gehry	 The Treehouse Design by Architect Frank Gehry	

Aldo Rossi (Italy) (P

Figure: Architect Aldo Rossi

Theory: Rossi's design theory evolved f
early Italian modernism, to surrealist pai
Chirico.

His book, *L'architettura della città* (The
City), is to this day considered a pioneeri
theory. The book argues that architects s
urban/cultural context, making use of his
precedent rather than trying to reinvent t
that the city remembers its past through
position is called neorationalist, since it
Italian rationalist architects of the 1920s
favored a limited range of building types

In his book, *A Scientific Autobiography*,
accident that occurred in 1971 as being a
life, ending his youth, and inspiring a pr
Cataldo Cemetery at Modena. It was wh
in a hospital that he began thinking of ci
encampments of the living, and cemeter

Figure: *San Cataldo, Modena*

Zaha Hadid, UK (Pritzker Prize 2004)

Figure: From parking garages and ski-jumps to vast urban landscapes, Zaha Hadid's works have been called bold, unconventional, and theatrical. The Iraqi-born British architect was the first woman to win a Pritzker Prize.

Dame Zaha Hadid (31 October 1950 – 31 March 2016) was the uncrowned queen of contemporary iconic architecture. Her buildings practically scream, "I'm a Hadid". A bona fide autrice, Hadid was without a doubt the world's most famous woman in a starchitect stratosphere strangely dominated by her masculine peers.

Since her student days in London at the Architectural Association School of Architecture, Iraqi-British architect Zaha Hadid (born 1950) had been intensely preoccupied with changing our general notions of space – not only in a physical sense, but also socially and culturally. Hadid's projects are characterized by their dynamic formal qualities of sinuously, curving shapes, or crystallized strata. This sums up as a kind of new Baroque, a sensuous, more vibrant and engaging type of architecture.
Hadid's projects during the late 1970s and 1980s were marked by a profound understanding of early 20th Century avant-garde artists and architects. In an attempt to redevelop and make relevant again the formal investigations of Russian Constructivism and Italian Futurism, her projects expressed utopian ideals.
Today, Zaha Hadid Architects create landmarks projects for all types of functional programs. Their buildings are never bland or mundane, but moreover assertive statements of a particular view, that the world may indeed look different. Their efforts have resulted in a staggering almost one thousand projects throughout the globe, in every scale, from urban design schemes to objects and furniture design.
Along with her strong conceptual and historical awareness, nature's forms and shapes appear as a recurrent source of inspiration for Zaha Hadid's architecture. It includes attention to physical contexts and landscapes, whether resulting in layered structures or powerful moving lines but also exploring possible interfaces between patterns and construction. Zaha Hadid Architects embraced digital drawing early on. This has made the studio able to challenge traditional ways of making architecture. In collaboration with senior office partner Patrik Schumacher, Zaha Hadid has meticulously explored the possibilities of parametric design, allowing for the conception and construction of architecture as seamless flows of energy and matter. Zaha Hadid is the 2004 Pritzker Prize laureate and winner of the Stirling Prize in 2010 and 2011. https://arcspace.com/architect/zaha-hadid-architects/

Famous buildings:
Richard and Lois Rosenthal
Center for Contemporary Art, Cincinnati, Ohio
Price Tower Arts Center, Bartlesville, Oklahoma
BMW in Leipzig
Guggenheim Museum for Taichung, Taiwan

Peter Zumthor (Switzerland) (Pritzker Prize 2009)

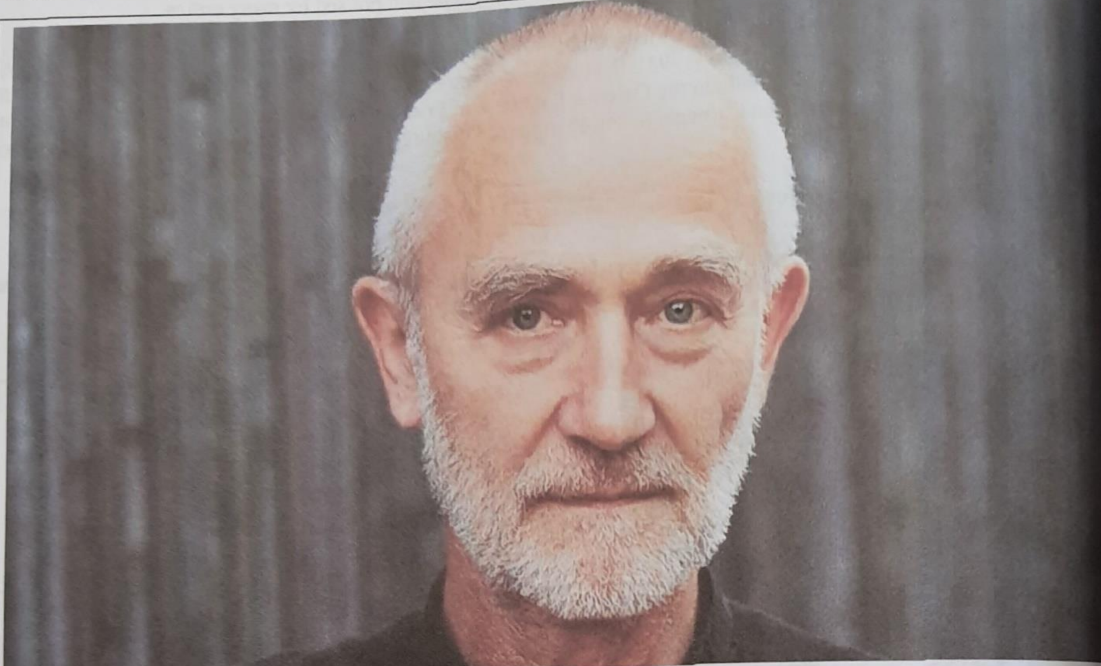

Figure: The son of a cabinet maker, Swiss architect Peter Zumthor is often praised for the detailed craftsmanship of his designs.

Buildings and Projects by Peter Zumthor:

Peter Zumthor writes: "I believe that architecture today needs to reflect on the tasks and possibilities which are inherently its own. Architecture is not a vehicle or a symbol for things that do not belong to its essence. In a society that celebrates the inessential, architecture can put up a resistance, counteract the waste of forms and meanings, and speak its own language. I believe that the language of architecture is not a question of a specific style. Every building is built for a specific use in a specific place and for a specific society. My buildings try to answer the questions that emerge from these simple facts as precisely and critically as they can."
~*Thinking Architecture* by Peter Zumthor

 1986: Protective Housing for Roman Excavations, Chur, Graubünden, Switzerland	 1988: Saint Benedict Chapel in Sumvitg, Graubünden, Switzerland	 1993: Homes for Senior Citizens in Masans, Graubünden, Switzerland	 1996: Thermal Bath at Vals, Graubünden, Switzerland
 2000: Swiss Sound Box, Swiss Pavilion, Expo 2000	 2002: Luzi House in Jenaz, Graubünden, Switzerland	 2007: Brother Klaus Field Chapel in Wachendorf, Eifel, Germany (Exterior)	 2007: Brother Klaus Field Chapel in Wachendorf, Eifel, Germany (Interior)

BV Doshi, (Pritzker Prize 2018)

Figure: "Balkrishna Doshi has always created an architecture that is serious, never flashy or a follower of trends," said the Pritzker jury.

Balkrishna Vithaldas Doshi was born in Pune in 1927. He did his bachelors from J. J. S chool of Art, Bombay in 195(He worked for four years with Le Corbusier as senior designer (1951 -54) in Paris. In 1956 he established a private practice Vastu -Shilpa, Ahmedabad and in 1962 he established the Vastu –Shilpa Foundation for Environmental Design. He also founded and designed the School of Architecture and Planning in Ahmedabad. Doshi has worked in partnership as Stein, Doshi & Bhalla since 1977. Doshi worked closely with Louis Khan and Anant Raje, when Kahn designed the campus of the Indian Institute of Management, Ahmedabad. In 1958 he was a fellow at the Graham Foundation for Advanced Studies in the Fine Arts. Doshi has been a member of the Jury for several international and national competitions including the Indira Gandhi National Centre for Arts and Aga Khan Award for Architecture. H was presented in 1995, Aga Khan Award for Architecture, for the Aranya Community Housing in Indore, India.

Philosophies: According to him Architecture of a building is conceived not as a container of specific activities but as place to be inhabited, as a place to facilitate the course of human environment. Doshi's work has consistently revolve around the interrelationship of indoor and outdoor space, an appropriate and honest approach to materials, proper climatic response and observance of hierarchy and order that has always been present in the best modern architecture.

It is this so called 'filter' between contemporary and traditional architecture which Doshi has masterfully brought in. The success of any project depends on effective construction, contracting, logistic planning and co-ordination. An essential part of the philosophy is the construction of scale models and of full scale mockups to make decisions jointly with the client about the building.

"I learned from Le Corbusier to observe and react to climate, to tradition, to function, to structure, to economy, and to the landscape. To an extent, I also understand how to build buildings and create spaces and forms. However, I have in the last two decades, gradually discovered that the buildings that I have desifned seems somewhat foreign and out of milieu; they do not appear to have their roots in the soil. With the esperience of my work over the years and my own observation, I am trying to understand a little about my people, their traditions, and social customs, and their philosophy of life." (B.V.Doshi, Contemporary Architects, 1987, p. 236.)

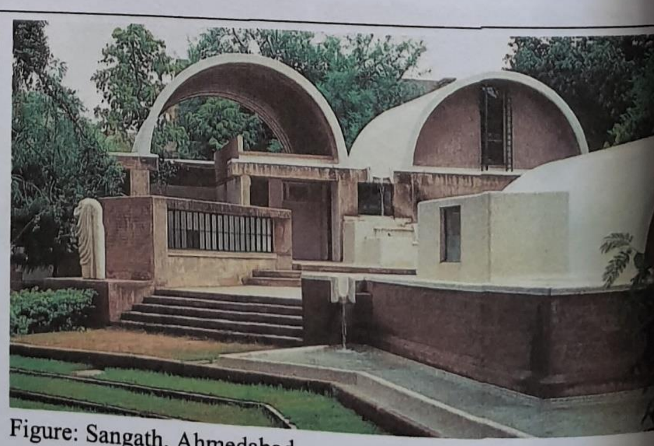

Figure: Sangath, Ahmedabad

Hafeez Contractor

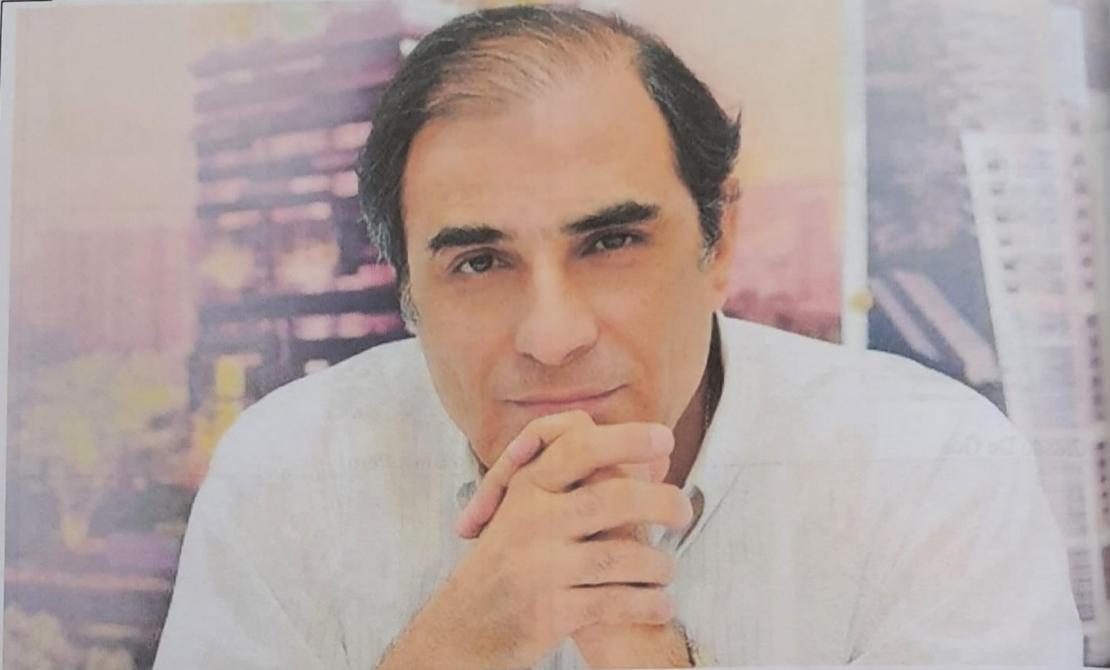

Figure: Hafeez Contractor is an Indian architect born in a parsi family in 1950 in Mumbai. He got his graduate diploma in architecture in 1975 from the University of Mumbai followed by bachelor's degree from the Academy of Architecture in Mumbai and master's degrees in Architecture from Columbia University, New York on a Tata scholarship.

Hafeez Contractor commenced his architectural practice in 1968 as an internee at his uncle, T. Khareghat's office while studying to get his architecture degree. After working for a while he became the associate partner in the same firm in 1977 and between the years from 1977 to 1980, he served as a visiting faculty member at the Academy of Architecture, Mumbai.

He set up his own architectural firm in 1983 with a staff of two and today his firm has grown to one of the largest architectural firms in India with around 500 employees. He has built a vast variety of buildings all over India but gained large chunk of success and fame due to his residential projects. He also owns the credit of making a couple of buildings with magnificent heights, The Imperial I and II being the tallest among them all. Other than that he has also designed one of the tallest residential buildings in the world, the 23 Marina in Dubai. Apart from tall towers, Hafeez also gained enough fame for his exuberant cricket stadium designs, railways stations, educational institutes, hotels, hostel blocks and majestic airport terminals with modernistic approach.

Hafeez shows great concern regarding the lack of greenery in India and rejects the idea of going behind western techniques and following their footsteps blindly as they don't go in accordance with the climatic conditions and other demands of this region. He proposes the installment of green spaces and public parks at walking distance from residential zones and other urban centers to minimize the scarcity of greenery and other natural resources.

Following are the major projects done by Hafeez Contractor:

- Sky Garden [Greater Noida (West)]
- Mahagun Meadows Noida
- The 42in Kolkata (under construction)
- DY Patil Stadiumin Nerul, Navi Mumbai
- Seawoods Estate (or NRI complex) in Nerul, Navi Mumbai
- DLF Aralias, Gurgaon
- One Indiabulls Center, Mumbai, India(Ongoing)
- Morya Regency in Bandra, Mumbai
- Rodas – An ecotel in Hiranandani Gardens, Powai
- Hiranandani Gardens
- Multiple Buildings, DLF City, Gurgaon

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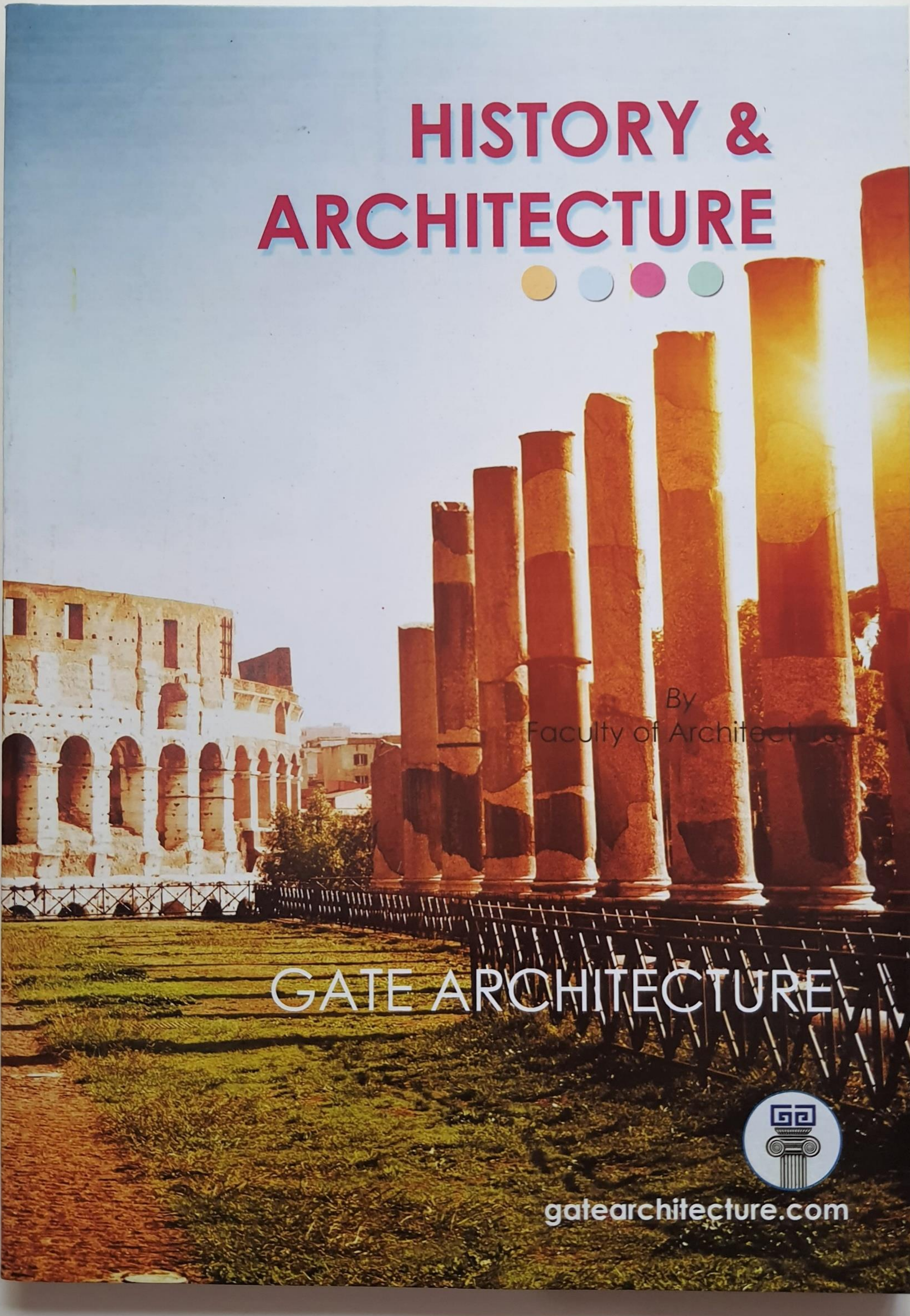
HISTORY &
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By
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gatearchitecture.com

- Well built bathrooms
- Wells throughout the city
- Remarkable similarity of architecture all over the civilization
- No large monumental structures

Figure: The large corbelled drain was built in the middle of an abandoned gateway at Harappa to dispose of rainwater and sewage.

Figure: Wells in some parts of Mohenjo-daro have been excavated in such a way that they appear to be towers. It stands like a chimney because all of the surrounding earth has been removed by excavation.

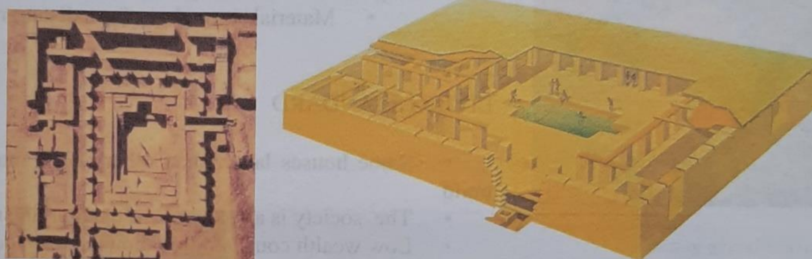


Figure: The Great Bath. The artist has cut through the roof and walls to show hidden detail.

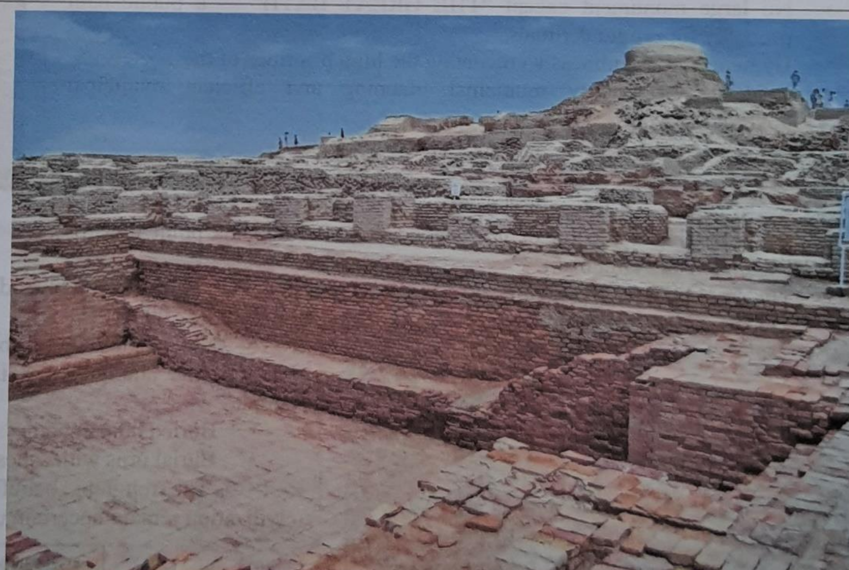


Figure: Mohenjo-Daro. The view of the Citadel (a fortress protecting a town), as seen from the lower town.

Bamayan Buddhas (destroyed)

Bamayan, Afghanistan 3rd century C.E. 150 feet tall.

Figure: Built in 3rd and 5th-centuries monumental statues of standing Buddha carved into the side of a cliff in the Bamyan valley in Afghanistan destroyed by Taliban in 2008.

Figure: Pagoda in Japan.

http://bit.ly/1QsnOaZ

Scan or visit for urther reading on Bamayan Buddhas

The Pagoda

The Pagoda is the general term in the English language for a tiered tower with multiple eaves common in China, Japan, Korea, Vietnam, and other parts of Asia. Most pagodas were built to have a religious function, most commonly Buddhist, and were often located in or near temples. This term may refer to other religious structures in some countries. The pagoda's original purpose was to house relics and sacred writings.

he Sun Temple of Konark, often called as the Black Pagoda, it's compound measures 857 ft (261 m) by 540 ft (160) The alignment of the Sun Temple is on the east-est direction.

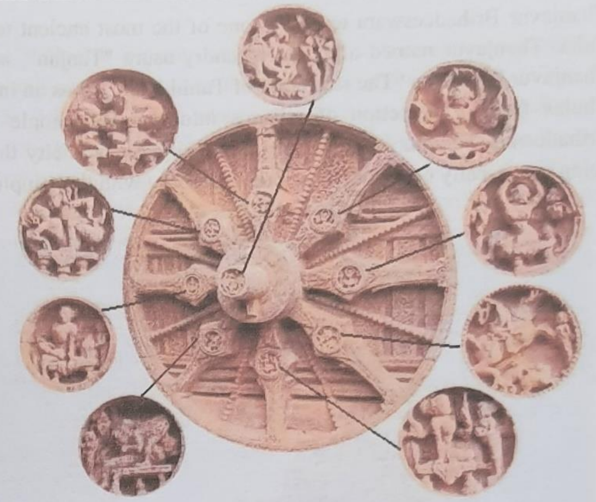


Figure: The wheels of the chariot are also symbolic and have been interpreted as the 'Wheel of Life'. They portray the cycle of creation, preservation and achievement of realisation..

he main sanctum which (229 ft. high) was nstructed along with the audience hall (128 ft. gh) having elaborate external projections.

alls to accommodate the new rituals were erected ong the main axis of the temple-The Bhog mandir, hall for the god to bless the food; and the nat andir for the dance perfomance by devadasis.

he temple was mounted on a huge Rath, On a umber of large wheels which had to be pulled by ousands of stout men.

he korank temple for the sun god is an allegoric one vision of the deity as described in the rig eda.

he entire planning concept of the spectacular mple is devised out of the perfectly square plans, of the deuls, the jagmohan & the nat mandir and their precise geometric subdivisions.

igure : Figures playing different musical instruments on wall of Dancing Hall.

Figure: Erotic Figure.

The main temple and the deuls of four accompanying eites at the cornres of the platform are all laid on the ground according to the strict regimen.

he mathematics of the vertical & horizontal dimensions follow the dictates of the vastu shashtra, e ancient treatis on the art and science of building.

Figure: Royal Guard of Konark - Lion Upon Elephant Upon Man.

The higher layer (above the basement and middle layers) of Konark Sun Temple contains a number of bigger sculptures, mostly erotic. There is a different interpretation. For the average man, the attainment of moksha (Success) can come after the fullfilment of all earthly desires, Dharma (religion), Artha (Wealth), Kama (desire) and not through repression. The figure of an ascetic seem to confirm the above interpretation.

While the Buddhism was preaching for renouncing everything for the purpose of achieving moksha (success), the Vaisnavism at that time were teaching people, that the achievement of success was possible, if he can fulfil all his desires even by staying among the members of his family. People can only think of this when he is almost disgusted with all sorts of enjoyments.

eenakshi Temple, Madurai

Figure: **Meenakshi Temple, Madurai.**

The temple complex is dedicated to Shiva, known here as Sundareshvara and his consort Parvati or Meenakshi. The temple complex is within a high-walled enclosure, he core of which are the two sanctums for meenakshi and Sundareshwara, surrounded by a number of smaller ines and grand pillared halls. Especially impressive are the 12 gopuras. Their soaring towers rise from solid granite es, and are covered with stucco figures of dieties, mythical animals and monsters painted in vivid colours.

pura

amidal es(gopuras) rise to a ght of more than n. These towering eways indicate the rance to the temple nplex at the four dinal points, while ser gopuras lead to sanctums of the in dieties.

Figure: **Stucco work.**

ucco Work

e figures of dieties the tower are aired, repainted and ally reconsecrated ery 12 years.

hta Shakthi Mandapam

visitor who enters the temple through the eastern gateway, first enters this Mandapam(Hall). In this hall food was e distributed to the devotees who came from far off places. Next to this hall is the

URBAN PLANNING & DESIGN

GATE ARCHITECTURE

By
Faculty of Architecture

gatearchitecture.com

Concepts of urban design

Key urban design concepts are:

- Physical comfort
- Circulation and accessibility
- Transitions and boundaries
- The connection between street and building
- Scale
- Detail, variety, and complexity
- Cohesiveness

Figure: **Physical Comfort:** A Market Street is designed to offer places to sit

Physical Comfort

Physical comfort is the basic concept in urban design for people to feel comfortable in a public place. There are basic needs like a good walking surface and some garbage bins, but a good environment also offers places to sit, some shade on a hot day, shelter from the rain, readily accessible public toilets, and decent lighting at night. It is also possible to physically design areas in a way that may help to deter crime.

Circulation and Accessibility

There should be a peaceful coexistence between the pedestrian and the car. Comprehending and feeling comfortable in the urban environment means that separation between pedestrian use, driving lanes, and parking must be easy to see and interpret. In many developments it will be important to reassert the priority of the pedestrian when looking at circulation.

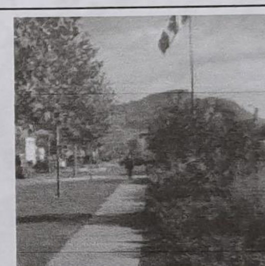


Figure: **Circulation and Accessibility:** Providing an adequate buffer strip and sidewalks can help people walkthrough easily.

Transitions and Boundaries

Most people feel a deep need to know where one neighborhood or district ends and another begins. A logical world with good spatial definition orients us and gives us information to help us make decisions about where to go and what to do. Elements such as the shape of buildings, doorway design, paving materials, curbs, landscaping, street furniture, changes in the elevation of the ground, and signage let us know where one category of uses gives way to another. The transitions and boundaries of the urban world tell us when we enter and leave the town, what is public and what is someone's private space, where to sit and meet people, where to stroll, where to shop, and where to drive or park. Using urban design to clearly show these transitions and boundaries can be the difference between comfort and confusion; and between feeling invited and feeling unwelcome.

Figure: **Transitions and Boundaries**: these can be effective in helping orient visitors where to go. Better with signage.

Figure: **Scale:** The varied rhythm of storefronts in towns helps establish a pedestrian-oriented scale.

Screens

Fast-growing evergreens, willow hybrids and privet shrubs offer a natural screen in the landscape, affording privacy while adding interest and beauty to the yard. In addition to trees and shrubs, vining plants, such as clematis and climbing rose, provide perennial cover for a fence. Annual vines, such as morning glory, cardinal vine, moonflower and Spanish flag, provide bursts of color on a trellis or an arbor.

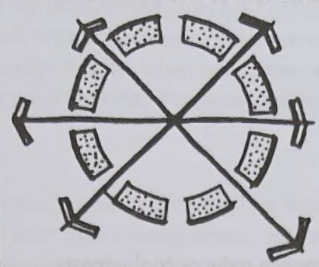


Figure: Outwardly oriented rooms are enhanced by amenities outside the space such as good views and breezes. Activities taking place within the front yard are more public in nature and will require free visual access on and off the site and little enclosure.

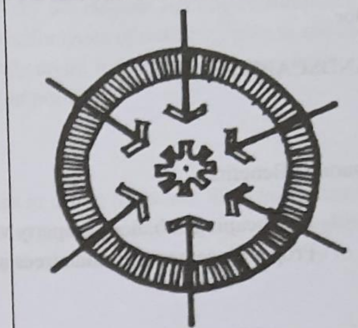


Figure: Inwardly oriented space is characterized by either complete or nearly complete enclosure and a strong central focal point. Central areas for sitting, sculpture displays, patios, and hot tubs require enclosure for purpose of privacy, quit, and concentration.

Shade

Large trees with dense leaf growth, such as maple, ash, oak and elm, provide welcome relief from the hot summer sun when positioned between the roof of the home and the angle of the sun at midday and afternoon.

Borders

Outlining a driveway or a sidewalk or enhancing the edge of a flower garden is ideal for border plantings. Shrubs or flowering plants of a similar height and shape form attractive borders and offer a visual separation between elements in the landscape. Both annual and perennial plants make attractive borders when chosen for their mature height and width, their texture or color, and their growth pattern. Tall plants, including butterpat, fountain grass and snow bank, look the best at the rear of the border, creating a backdrop for shorter plants such as variegated lily and marigold.

Ground Cover

While grass may be the most common ground cover, you can reduce soil erosion, create a blanket of texture or add color beneath trees or in bordered areas. Low-growing plants that spread, such as vinca, creeping phlox, ivy, creeping juniper and ajuga, create a living plant carpet. For permanent ground cover in the landscape, choose hardy plants that will continue to grow each year.

Types of Plants

There are about 350,000 plus plant species, their classification gets a little difficult. However, most of them are categorized in the following three types:

- Mosses: Mosses are very tiny plants with equally tiny leaves and no flower-bearing capacity. They do not have true roots like other plants, but very thin hair like structures known as a filament that holds them down. They have no seeds, but spores which they use to multiply.
- Grasses: Grass can be identified by their distinct leaves; narrow, slender and usually long. They may or may not bear flowers that are made up of three or six parts which are either ways inconspicuous. The roots are in clump form.

2. Central places will be regularly spaced clusters located with in hexagonal trading areas and will together for triangular lattices
3. Lower order centers will be located at the gravity centers of the triangles formed by next higher order centers
4. Distances separating the centers will be greater in case of higher order centers and proportionally less for lower order centers
5. All the central places constitute a hierarchy of the smallest villages to the largest town of national importance

SETTLEMENT PATTERN

Census of India defines an Urban Area as

(i) all places with a municipality, corporation, cantonment board or notified town area committee;

(ii) all other places which has features as

(1) a minimum population of 5000;

(2) at least 75% of the male working population engaged in non- agricultural pursuits and

(3) a density of population of at least 400 persons per sq. km.

Apart from urban area & urban agglomeration rest is considered as Rural Area.

Census Classification of Cities and Towns:

Class of Cities/Towns	Range of Population
Class I	100,000 and above
Class II	50,000 to 99,999
Class III	20,000 to 49,999
Class IV	10,000 to 19,999
Class V	5,000 to 9,999
Class VI	Below 5,000

Source: Report of National Commission on Urbanization

LANDUSE AND LAND UTILISATION

At any particular point of time, a parcel of land put to some use is landuse. This concept is a dynamic phenomenon as the use of a vacant land may be converted to residential or commercial.

Need for 'land use'

- To guide the use of land to promote the advantages of development of the community
- Curb misuse of land i.e. increased intensity of development, encroachment of open space
- Prevent abuse of land i.e. prevent formation of slums, squatters
- Regulate the nonuse or misuse of land i.e. land being used for speculation, without development
- To guide the re-use of land i.e. conservation

Land use plan

Landuse plans show us the various kinds of activities that are carried out in the different location of the city. There are various types of landuses in a city.

SURVEY METHODS

TYPES OF SURVEYS

Surveys can broadly be divided into two categories depending on the area upon which they are to be conducted. They are :

REGIONAL SURVEYS

They are those surveys, which are done over a region dealing with

- PHYSICAL FACTORS like topography, physically difficult land, geology, landscape etc.
- PHYSICAL ECONOMIC FACTORS like agricultural value of the land, mineral resources and water gathering lands, areas with public services, transportation linkages etc.
- SOCIAL ECONOMIC FACTORS like areas of influence of towns and villages, employment, population changes etc.

TOWN SURVEYS

They are done at much small scale and apart from the above data collected from the regional surveys it also ncludes

- LANDUSE SURVEYS
- DENSITY SURVEYS
- SURVEYS FOR THE AGE AND CONDITION OF THE BUILDINGS
- TRAFFIC SURVEYS
- OTHER SOCIAL SURVEYS

For conducting proper survey, primarily relevant enquiries should be framed in the form of questionnaires for presentation, when required.

ECHNIQUES OF SURVEYS

f the various techniques of surveys that are followed, the four listed below are most prominent

1. self surveys (i.e. mailing questionnaires to the persons to be surveyed)
2. interviews (i.e. by asking questions to the people to be surveyed)
3. direct inspection (i.e. when the surveyor himself inspects the situations concerned)
4. observers participation (i.e. when the observer himself participate in acquiring the data required)

CALES FOR STRUCTURING QUESTIONNAIRES

e questions that are asked in the questionnaires formed for doing the surveys can be of various types. Some of e asks for general things, some asks for some order of preferences or some give stress to the time erval between two incidents. Thus the scales of the questionnaires are fixed, which can be described as follows

OMINAL where there is no ordering, like asking of sex, age, employment in any particular service etc.
RDINAL where there is a specific order of choices like asking of priorities, housing conditions, climate etc.
TERVAL where an interval of time is given importance like time taken to shift from LIG housing to MIG using, time interval to change from two wheelers to four wheelers etc. this provides an yardstick of measurements

LECTION OF SAMPLES

conducting surveys, it is not always possible to ask each person about his or her opinion. Hence, certain nbers of persons are selected for conducting the surveys and these selected persons are known as 'samples' of veying. The selection of the number of samples is of utmost importance. The basic rules for selection of nple size are as follows:

1. MORE DISASTROUS THE RESULTS OF POOR INFORMATION, LARGER SAMPLE SIZE IS REQUIRED. That is if the information got are poor (both qualitatively and quantitatively) the analysis done from them will be wrong. Thus, if getting incorrect results have a very disastrous effect on the

6. Desirable densities of population

Particulars	Persons per hectare
Average gross density for the city	100
Average gross density for the community	150 - 200
Net density for residential neighborhood	200 - 250
Gross density at the periphery and suburbs including lowland value areas	100
Intermediate rings of cities and districts	200
Inner ring around core area	250 - 375
Core of city and high land value areas	500

7. Residential plot sizes for towns in India

Income group	Dimensions in mts.	Area in sq.mts.
Low income group	9 x 15	135
	12 x 15	180
Middle income group	12 x 18	216
	14 x 21	294
High income group	15 x 24	360
	18 x 27	486
	24 x 30	720
	27 x 36	972
Public housing and multiple family plots (90 sq.m. per family with 12 m. to 18m. road)	90 x 90	8100
	90 x 180 and multiples of 90	16,200

8. Plot area coverage and floor area ratio

Residential

Area of plot in sq.m.	Max. Percentage of coverage
100 - 200	65
200 - 300	60
300 - 400	55
400 - 500	50
500 - 1,000	45
Above 1000	40

Floor area ratio: 1.0 to 3.0

Commercial

Area of plot in sq.m.	Max. Percentage of coverage
Up to 100	80
100 - 300	75
300 - 400	70
400 - 500	65
500 - 1,000	50
1000 - 2000	40
Above 2000	35

Floor area ratio: 1.0 to 4.0

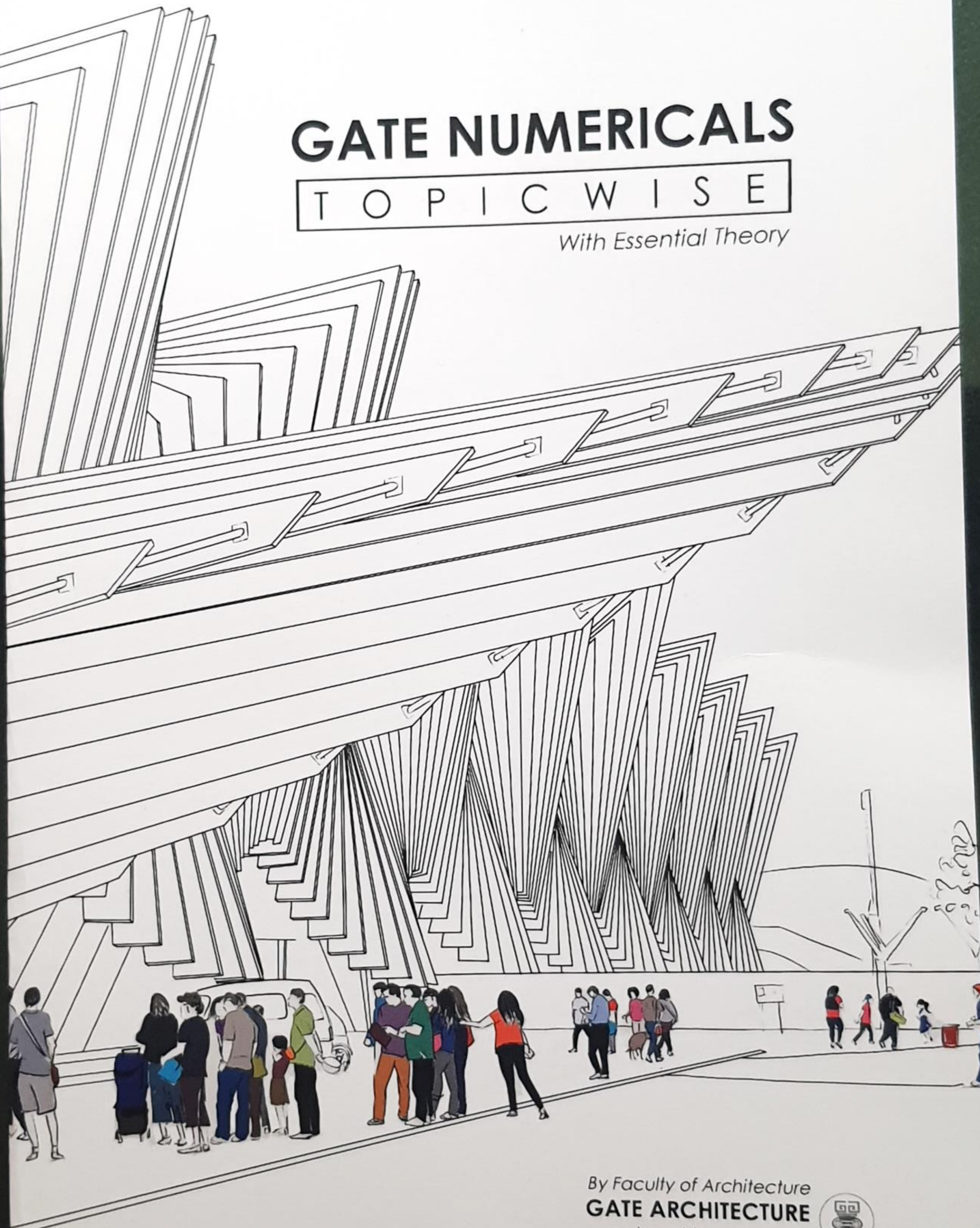
Industrial

	Area of plot in sq.m.	Max. Percentage of coverage
Light industry	250 - 2000	50
Medium industry	2000 - 4000	40
Heavy industry	Above 4000	35

GATE NUMERICALS

TOPICWISE

With Essential Theory



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GATE NUMERICALS

TOPICWISE

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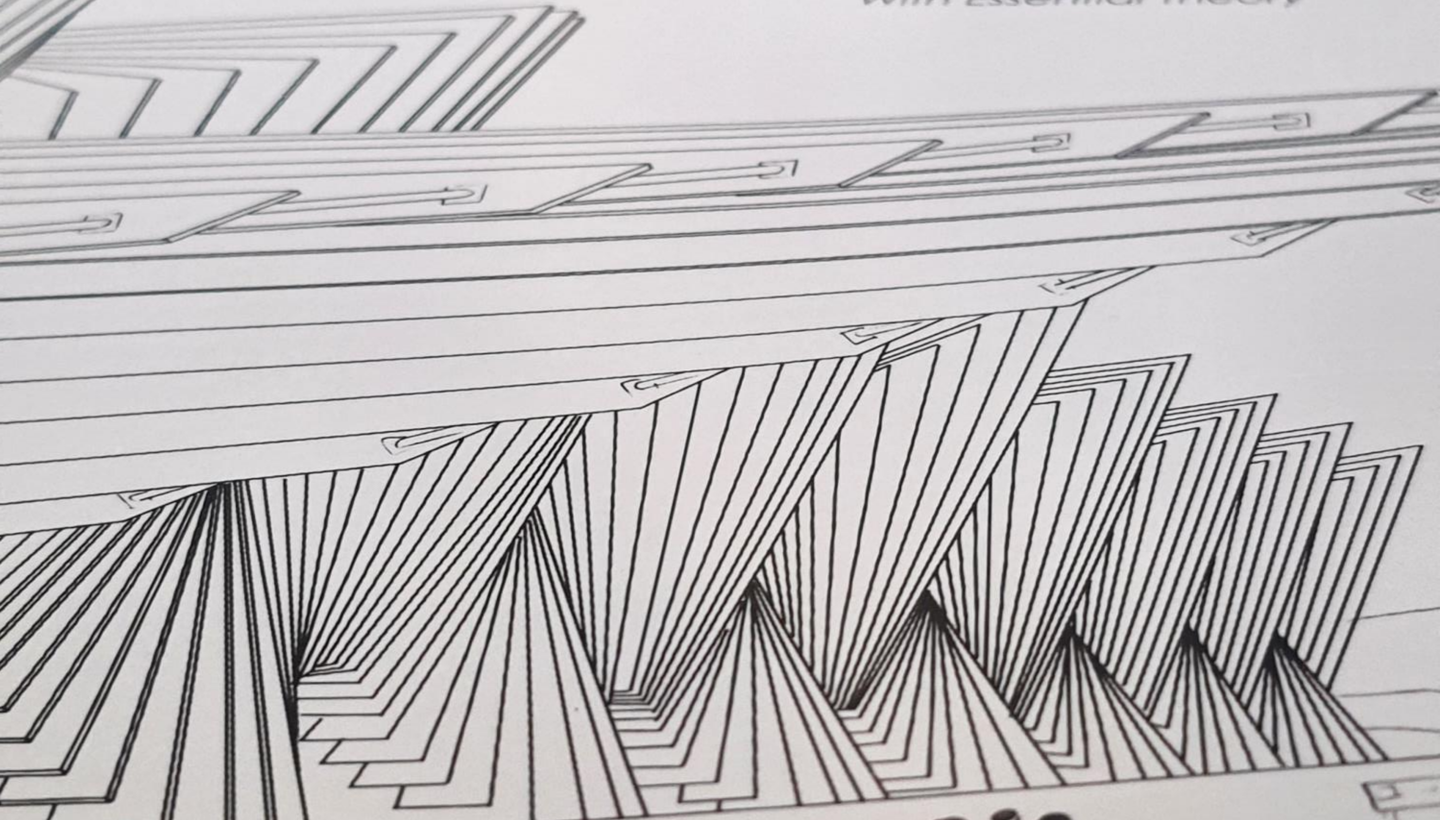

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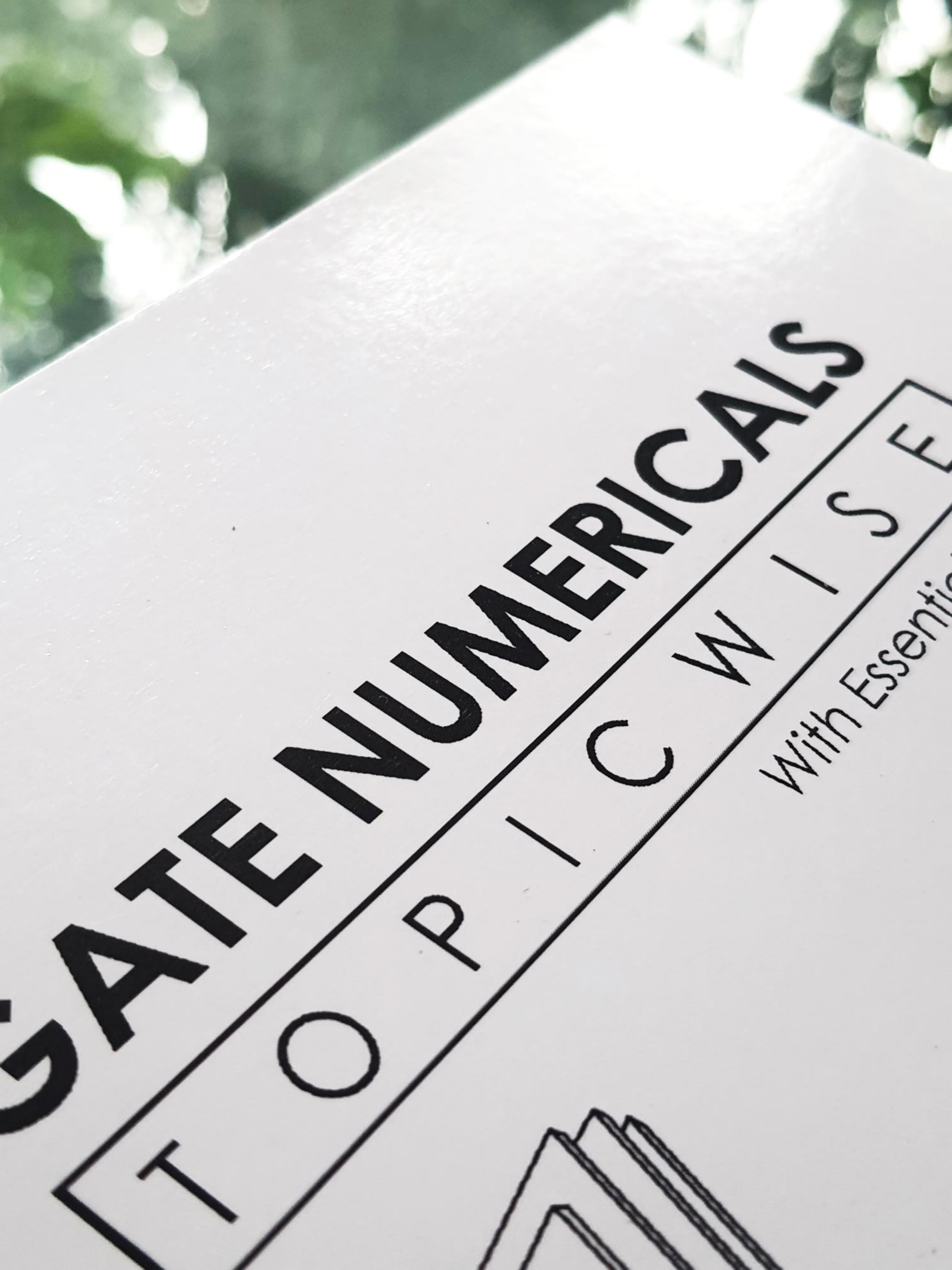
GATE NUMERICALS
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31 YEARS

2021 - 1991

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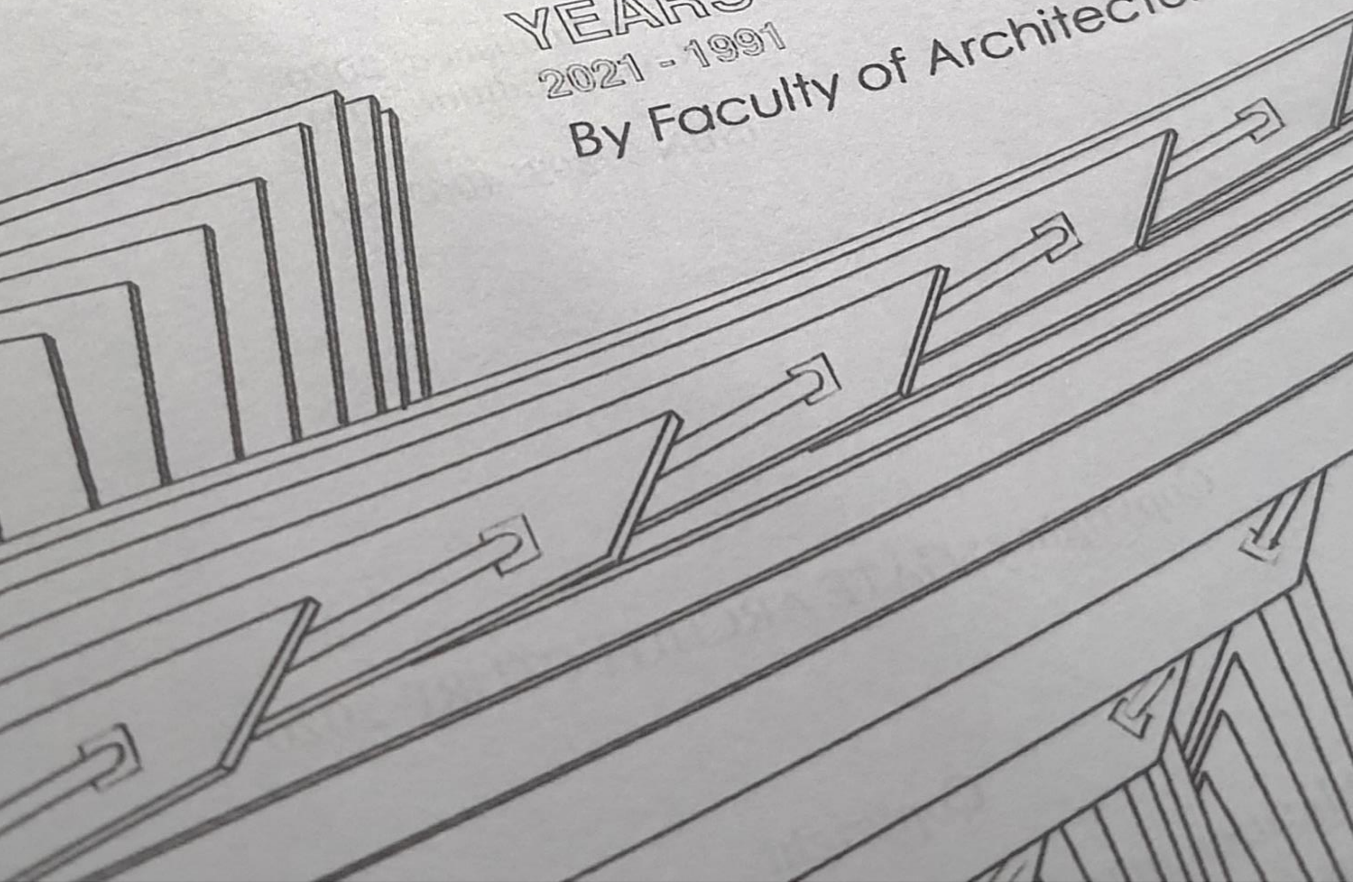
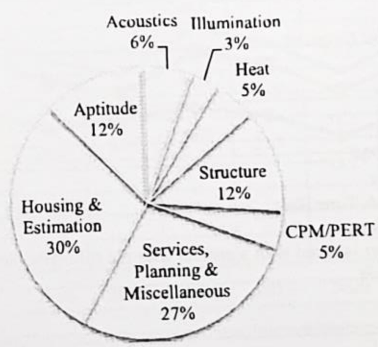


Short contents:



% Distribution of Numerical Questions (2020 - 1991)

Long contents:

Preface

This book will add an edge to your preparation by reviewing sets of numerical questions asked in previous years. In past few years, the pattern of numerical question has changed. In GATE 2021, there were total 18 numerical questions of out of total 65 questions. For most of the questions, no option had been given. You have to answer the question by using keypad displayed on the screen. (Use of keyboard is prohibited. Touching any key would lock your monitor screen and you may not able to answer any further question!)

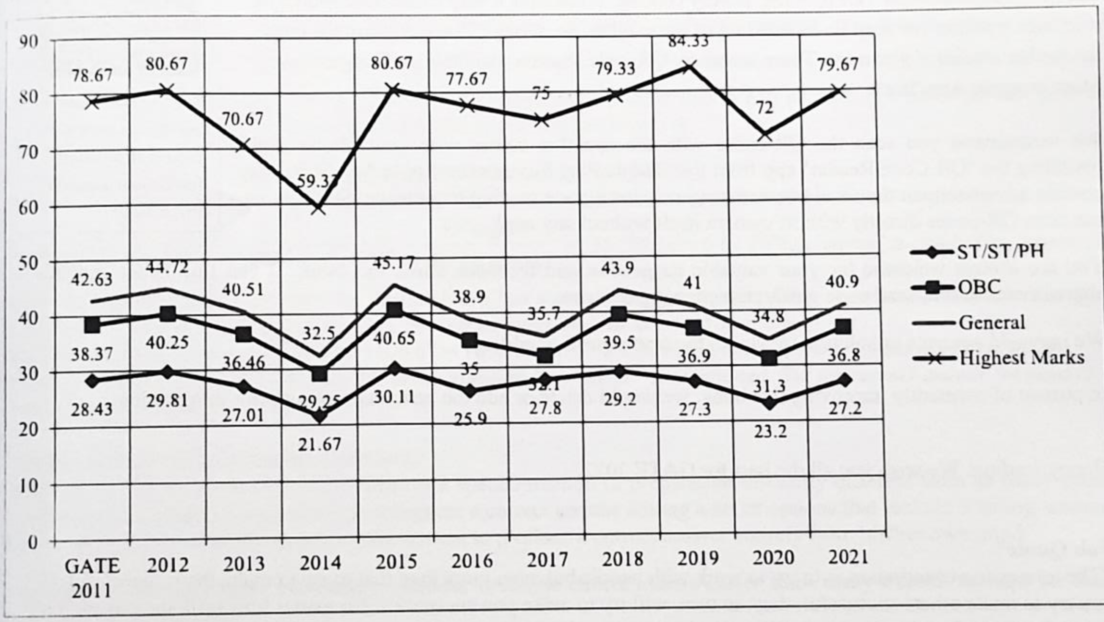
So, for such question pattern, you need through practice. We are hopeful that this book would meet the requirement.

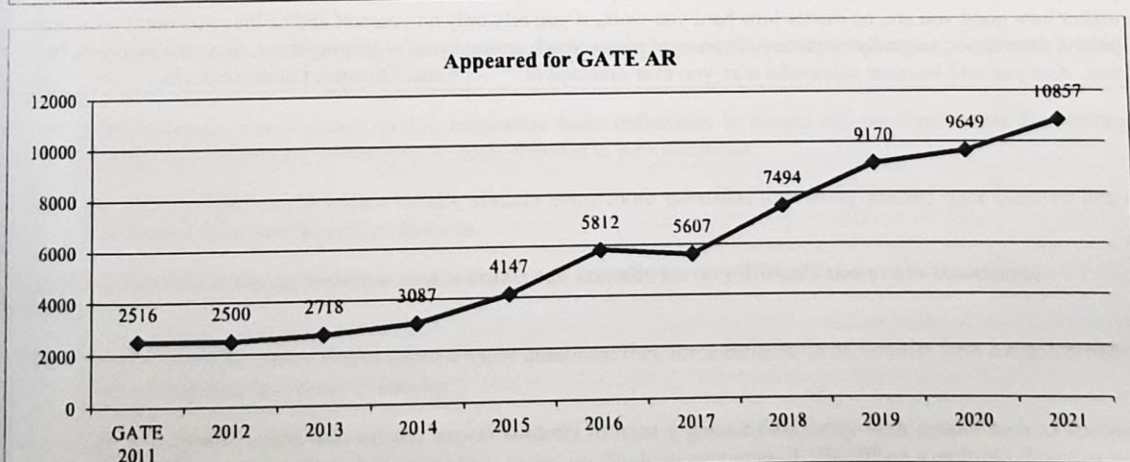
Answering an objective question has its own rule to follow when you have a doubt in choosing the right answer. For so, we have also attached expert opinion for handling objective question well.

Topicwise Questions: It is an important feature of this book. Based on feedback of GATE aspirants.

Essential Notes: It has been provided for each topic so that you could easily understand the concept. All questions have been solved except few. Alternative answers have been provided for few questions.

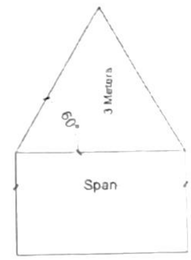
(GATE AR Cut-off marks & Highest mark trend):





Tips & Tricks

Followings are tips & tricks for handling multiple choice questions suggested by experts from open source online resources. Please note that following insights are not only for Numerical Questions but also for all topics. Some of the followings are for paper bound exam (not online). You should skip those.



Tips for solving numerical problems:

Drawing the picture of the problem is very important! The correct picture of a numerical problem is more than 80% of success.

Example (GATE 2013): If the slope of a hipped roof is 60° and height of the roof is 3 m, span of the room, in m, would be _____
Solution: Span of the room = 2 * (3/tan60°) = 3.46 answer.

Having the same units for all variables in the problem. You must ensure that you solve the problem in the same unit. For example, in a given question, force may be given 40 Newton (N) and length of the beam would be $l = 50$ centimetre. For easy and correct solution, you should change the length in meter ($l = 0.5$m). Tip: If the option is given as follows: (A) 50Pa (B) 5Pa (C) 10Pa (D) 100Pa. For this type of question, you must recheck your solution before you choose an answer.

Checking the dimensionality of analytical expressions. To arrive at correct answer, you should always write the numerical value with it's unit.

Example: Area of tense steel per meter width of a reinforced concrete slab is 335 sq mm. If 8 mm rods are used as reinforcement, then centre to centre spacing of the reinforcement in mm is

Solution: Total area of steel is 335 sq mm. (which is spread in 1m of width)
Area of 8 mm rod = Πr^2 = 3.14 x 4mm x 4mm = 50.24 sq mm { *8mm rod means it has a diameter of 8mm*

So, total no. of rods spread in 1m of width = $\frac{335sqmm}{50.24sqmm}$ = 335 /50.24 = 6.67 {*When 'sqmm' is divided by 'sqmm', it becomes a dimensionless quantity. So, the result is a just number without any unit. Here, we want to calculate 'no. of rods', which does not have any dimension. So, our calculation is in the right direction.*
So, distance between two rods will be 1m/6.67 = 1000 mm/6.67 = 150 mm Answer { *Here, please note that we are dividing 1000mm /6.67 and not 1m/6.67. In the question "per meter" is mentioned. But for correct answer we need to convert 1m to 1000mm.*

Taking Multiple Choice Exams *(Source:1)*
Studying for a multiple choice exam requires a special method of preparation distinctly different from an essay exam. Multiple choice exams ask a student to recognize a correct answer among a set of options that include 3 wrong answers (called *distracters*), rather than asking the student to produce a correct answer entirely from his/her own mind.

For many reasons, **students commonly consider multiple choice exams easier than essay exams**. Perhaps the most obvious reasons are that:

- The correct answer is *guaranteed* to be among the possible responses. A student can score points with a lucky guess.
- Many multiple choice exams tend to emphasize basic definitions or simple comparisons, rather than asking students to analyze new information or apply theories to new situations.
- Because multiple choice exams usually contain many more questions than essay exams, each question has a lower point value and thus offers less risk.

Despite these factors, however, **multiple choice exams can actually be very difficult and are in this course.** Consider that:

- Because multiple choice exams contain many questions, they force students to be familiar with a much broader range of material than essay exams do.
- Multiple choice exams also usually expect students to have a greater familiarity with details such as specific dates, names, or vocabulary than most essay exams do. Students cannot easily "bluff" on a multiple choice exam.

Syllabus 2021

Part A: General

Section 1: Architecture, Planning and Design
Architectural Graphics; Visual composition in 2D and 3D; Computer application in Architecture and Planning; Anthropometrics; Organization of space; Circulation- horizontal and vertical; Space Standards; Universal design; Building byelaws; Codes and standards;

Section 2: Construction and Management
Project management techniques e.g. **PERT, CPM etc.; Estimation and Specification**; Professional practice and ethics; Form and Structure; Principles and design of disaster resistant structures; Temporary structures for rehabilitation;

Section 3: Environmental Planning and Design
Natural and man-made ecosystem; Ecological principles; Environmental considerations in Planning and design; Environmental pollution- types, causes, controls and abatement strategies; Sustainable development, goals and strategies; Climate change and built environment; Climate responsive design;

Section 4: Urban Design, landscape and Conservation
Historical and modern examples of urban design; Elements of urban built environment –urban form, spaces, structure, pattern, fabric, texture, grain etc.; Concepts and theories of urban design; Principles, tools and techniques of urban design; Public spaces, character, spatial qualities and Sense of Place; Urban design interventions for sustainable development and transportation; Development controls – **FAR**, densities and building byelaws.; Urban renewal and conservation; heritage conservation; historical public spaces and gardens; Landscape design; **Site planning;**

Section 5: Planning process
Salient concepts, theories and principles of urban planning; concepts of cities - Eco-City, Smart City; Concepts and theories by trendsetting planners and designers; Ekistics; Urban sociology; Social, Economic and environmental cost benefit analysis; Methods of non-spatial and spatial data analysis; Development guidelines such as URDPFI;

Section 6: Housing
Housing typologies; Concepts, principles and examples of neighbourhood; **Residential densities; Affordable Housing; Real estate valuation;**

Section 7: Services and Infrastructure
Firefighting Systems; Building Safety and Security systems; Building Management Systems; Water treatment; **Water supply and distribution system; Water harvesting systems**; Principles, Planning and Design of storm water drainage system; Sewage disposal methods; Methods of solid waste management - collection, transportation and disposal; Recycling and Reuse of solid waste; Land-use – transportation - urban form inter-relationships; Design of roads, intersections, grade separators and parking areas; Hierarchy of roads and level of service; Para-transits and other modes of transportation, Pedestrian and slow moving traffic planning;

Part B1: Architecture

Section B1.1: History and Contemporary Architecture
Principles of Art and Architecture; World History of Architecture: Egyptian, Greco-Roman classical period, Byzantine, Gothic, Renaissance, Baroque-Rococo, etc.; Recent trends in Contemporary Architecture: Art nouveau, Art Deco, Eclecticism, International styles, Post Modernism, Deconstruction in architecture, etc.; Influence of Modern art and Design in Architecture; Indian vernacular and traditional Architecture, Oriental Architecture; Works of renowned national and international architects;

Section B1.2: Building Construction and Structural systems
Building construction techniques, methods and details; Building systems and prefabrication of building elements; Principles of Modular Coordination; Construction planning and equipment; Building material characteristics and applications; **Principles of strength of materials**; Alternative building materials; Foundations; Design of structural elements with different materials; **Elastic and Limit State design; Structural systems;** Principles of Pre-stressing; High Rise and Long Span structures, gravity and lateral load resisting systems;

Section B1.3: Building Services and Sustainability
Solar architecture; Thermal, visual and acoustic comfort in built environments; Natural and Mechanical ventilation in buildings; **Air-Conditioning systems**; Sustainable building strategies; Building Performance Simulation and Evaluation; Intelligent Buildings; **Water supply; Sewerage and drainage systems**; Sanitary fittings and fixtures; Plumbing systems; Principles of internal and external drainage system; **Principles of electrification of buildings**; Elevators and Escalators - standards and uses;

Part B2: Planning

Section B2.1: Regional and Settlement Planning
Regional delineation; settlement hierarchy; Types and hierarchy of plans; Various schemes and programs of central government; Transit Oriented Development (TOD), SEZ, SRZ etc.; Public Perception and user behaviour; National Housing Policies, Programs and Schemes.; Slums, Squatters and informal housing; Standards for housing and community facilities; Housing for special areas and needs;

rchitectural Acoustics

ound is such a common part of everyday life that we rarely appreciate all of its functions. It provides enjoyable xperiences such as listening to music or to the singing of birds.

et, too often in our modern society, sound annoys us. Many sounds are unpleasant or unwanted - these are called noise. owever, the level of annoyance depends not only on the quality of the sound but also our attitude towards it. For xample, the type of music enjoyed by some people could be regarded as noise by others, especially if it is loud.

he branch of science which deals with the planning of a building to provide the best quality audible sound to the audience termed as architectural acoustics or acoustics of the building.
coustics is the science of sound. It relates to recorded music, to speech and hearing, to the behavior of sound in concert alls and buildings, and to noise in our environment. It is the technology of designing spaces and systems that meets our uditory needs. Architectural acoustics deals with sound in and around buildings of all kinds. Good acoustical design nsures the efficient distribution of desirable sounds as well as the exclusion of undesirable sound. All acoustical ituations consist of three parts: *(1) source, (2) Path, and (3) Receiver.*

ound

- Definition: An energy that is propagated by vibration in an elastic medium such as air, water, most building materials, and earth.
- Cycle, period, and frequency of sound: A full circuit by a particle of a medium displaced by vibration is a *cycle*. Time required to complete one cycle is called the *period*. Number of complete cycles per second is the *frequency* of sound. Unit of frequency is *Hertz (Hz)*.
- Wavelength: The distance a sound wave travels during one cycle of vibration. *Wavelength = Velocity of sound/Frequency of sound.*
- Sound intensity: Sound travels freely in all directions (i.e. spherically). Sound intensity is the strength of sound per unit area of a spherical surface.
- The decibel scale: It is used to measure sound intensity. In decibel scale, (1) min. intensity of perceptible sound is given a value of 0, (2) whole numbers are used, and (3) an increase of every ten units equals a doubling of loudness. It is a logarithmic scale.
    - Inverse-square law: Sound intensity decreases at a rate inversely proportional to the square of the distance from the sound source. The relationship can be expressed as:
        - $I = W/4\pi r^2$
        - Where I = sound intensity in watts per square centimeter; W = sound power in watts; r = distance from the sound source in centimeter.

Sound propagation

- Direct: Reaches the receiver directly from the source.
- Reflection: Occurs when sound waves bounce off a surface at the same angle at which it was incident on the surface.
- Diffraction: It is the bending or flowing of a sound wave around an object or through an opening.
- Diffusion: Scattering or random distribution of sound from a surface.
- Reverberation: Persistence of sound after source of sound has ceased. Results from repeated reflections. Some reverberation is good (particularly for musical performances), but not always desirable. Intelligibility and subjective quality of sound are rated by reverberation time (RT).
- Echo: Distinct repetition of original sound clearly heard above the general reverberation. A reflected sound can be perceived as discrete echo if the reflected sound wave is heard 0.05 second or later after it was heard as a direct sound.

Sound absorption

- When sound energy strikes a surface, part of the energy is absorbed. Reverberation and echoes may be controlled by effective use of sound absorption quality of a surface. Acoustic absorption is defined in terms of an absorption coefficient. It is the ratio of absorbed sound intensity by a material to the intensity of the sound source.
  Absorption coefficient = absorbed sound intensity / total intensity of sound source.
  *Total absorption by a surface = surface area * absorption coefficient.* Unit of sound absorption is *Sabin.*

Ray diagram

- Ray diagram is analogous to specular reflection of light. Analysis of ray diagrams can be used to study the effect of room shape on the distribution of sound and to identify surfaces that may produce echoes. A ray diagram shows both reflected and direct sound paths. The difference between these two paths is called path difference (Path Difference = Reflected Path - Direct Path). A path difference in excess of the distance that can be traveled by a sound wave in 0.05 seconds indicates that the reflected sound can be perceived as discrete echo.

Remember that sound-pressure level in air means that the reference pressure (p_{ref}) in the pressure ratio is 20 μPa. There are other reference quantities; some of the commonly used ones are listed in Table 2-3. The prefixes of Table 2-4 are often employed when dealing with very small and very large numbers. These prefixes are the Greek names for the power exponents of 10.

Prefix	Symbol	Multiple
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
mili	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

Figure: Prefixes, Symbols and exponents

Acoustic Power

It doesn't take many watts of acoustic power to produce very loud sounds. A 100-W amplifier may be driving a loudspeaker, but loudspeaker efficiency (output for a given input) is very low, perhaps on the order of 10%. A typical loudspeaker might radiate 1 W of acoustic power. Increasing amplifier power to achieve higher acoustic levels can be frustrating. Doubling amplifier power from 1 to 2 W is a 3-dB increase in power level (10 log 2 = 3.01), yielding a very small increase in loudness. Similarly, an increase in power from 100 to 200 W or 1,000 to 2,000 W yields the same 3-dB increase in level.

Sound Source	Sound Pressure (Pascal, Pa)	Sound Pressure Level (dB)
Saturn rocket	100,000	194
Ram jet	2,000	160
Propeller aircraft	200	140
Riveter	20	120
Heavy truck	2	100
Noisy office or heavy traffic	0.2	80
Conversational speech	0.02	60
Quiet residence	0.002	40
Leaves rustling	0.0002	20
Hearing threshold, excellent ears at frequency maximum response	0.00002	0

Figure: Examples of sound pressure and Sound Pressure Level

Example: Sound-Pressure Level

A sound-pressure level (SPL) is 78 dB. What is the sound pressure?

$$78\text{ dB} = 20 \log p/(20 \times 10^{-6})$$

$$\log p/(20 \times 10^{-6}) = 78/20$$

$$p/(20 \times 10^{-6}) = 10^{3.9}$$

$$p = (20 \times 10^{-6})\ (7{,}943.3)$$

$$p = 0.159 \text{ Pa}$$

Remember that the reference level in SPL measurements is 20 μPa.

Example: Loudspeaker SPL

An input of 1 W produces a SPL of 115 dB at 1 m. What is the SPL at 6.1 m (20 ft)?

$$SPL = 115 - 20 \log (6.1/1)$$
$$= 115 - 15.7$$
$$= 99.3 \text{ dB}$$

The assumption made in the 20 log 6.1 factor is that the loudspeaker is operating in a free field and that the inverse square law is valid in this case. This is a reasonable assumption for a 20-ft distance if the loudspeaker is remote from reflecting surfaces.

A loudspeaker is rated at a sound-pressure level of 115 dB on axis at 1 m with 1 W into 8 Ω. If the input were decreased from 1 to 0.22 W, what would be the sound-pressure level at 1-m distance?

$$SPL = 115 - 10 \log (0.22/1)$$
$$= 115 - 6.6$$
$$= 108.4 \text{ dB}$$

Note that 10 log is used because two powers are being compared.

Example: Microphone Specifications

An omnidirectional dynamic microphone open-circuit voltage is specified as −80 dB for the 150-Ω case. It is also specified that 0 dB = 1 V/μbar. What would be the open-circuit voltage n in volts?

$$-80 \text{ dB} = 20 \log v/1$$
$$\log v/1 = -80/20$$
$$v = 0.0001 \text{ V}$$
$$= 0.1 \text{ mV}$$

Example: Line Amplifier

A line amplifier (600 Ω in, 600 Ω out) has a gain of 37 dB. With an input of 0.2 V, what is the output voltage?

$$37 \text{ dB} = 20 \log (v/0.2)$$
$$\log(v/02) = 37/20$$
$$= 1.85$$
$$v/0.2 = 10^{1.85}$$
$$v = (0.2)(70.79)$$
$$v = 14.16 \text{ V}$$

Example: General-Purpose Amplifier

An amplifier has a bridging input impedance of 10,000 Ω and an output impedance of 600 Ω. With a 50-mV input, an output of 1.5 V is observed. What is the gain of the amplifier? The voltage gain is:

$$\text{Voltage gain} = 20 \log (1.5/0.05)$$
$$= 29.5 \text{ dB}$$

It must be emphasized that this is not a power level gain because of the differences in impedance. However, voltage gain may serve a practical purpose in certain cases.

Example: Concert Hall

A seat in a concert hall is 84 ft from the tympani. The tympanist strikes a single note. The sound-pressure level of the direct sound of the note at the seat is measured to be 55 dB. The first reflection from the nearest sidewall arrives at the seat 105 msec after the arrival of the direct sound. (A) How far does the reflection travel to reach the seat? (B) What is the SPL of the reflection at the seat, assuming perfect reflection at the wall? (C) How long will the reflection be delayed after arrival of the direct sound at the seat?

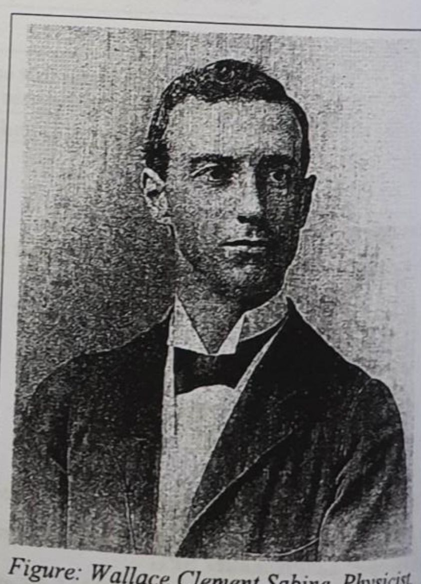


Figure: Wallace Clement Sabine, Physicist, Harvard Professor, and the Founder of Architectural Acoustics (Photo: Sabine Memorial).

$$L_2 - L_1 = 10\left[\log\left(\frac{I_2}{I_0}\right) - \log\left(\frac{I_1}{I_0}\right)\right]$$

$$= 10\left[\log\left(\frac{I_2}{I_1}\right)\right]$$

but $\frac{I_2}{I_1}$ = 2 (given)

$$\therefore L_2 - L_1 = 10 \log 2$$

$$= 10\,(0.3010)$$

$\therefore L_2 - L_1 = 3.01$ dB **Answer.**

Example: An air conditioner unit operates at a sound intensity level of 70 dB. If it is operated in room with an existing sound intensity level of 80 dB, what will be the resultant intensity level.

Solution : Here for case – 1

Intensity level is 70 dB

$$\therefore 70 = 10 \log L_1 = 10 \log \left(\frac{I_1}{I_0}\right)$$

$$\therefore \frac{I_1}{I_0} = \text{Antilog } 7.0$$

or $I_1 = 10^7\, I_0$ watts/m^2 …(1)

Similarly for Case – 2, intensity level is 80 dB.

$$\therefore 80 = 10 \log L_2 = 10 \log \left(\frac{I_2}{I_0}\right)$$

$$\therefore \frac{I_2}{I_0} = \text{Antilog } 8.0$$

$\therefore I_2 = 1 \times 10^8\, I_0$ watts/m^2 …(2)

$\therefore$ Resultant intensity

$$I = I_1 + I_2$$

$$= 10^7\, I_0 + 10^8\, I_0$$

$$= I_0\,(1.1 \times 10^8)$$

$\therefore$ Resultant intensity level in dB

$$L = 10 \log \left(\frac{I}{I_0}\right)$$

$$= 10 \log \left(\frac{1.1 \times 10^8\, I_0}{I_0}\right) = 10 \log (1.1 \times 10^8)$$

$$= 80.41 \text{ dB}$$

$\therefore$ Resultant intensity level (in dB) is 80.41 **Answer.**

Example: The noise form an aeroplane engine 100 m from an observer is 40 dB in intensity. What will be the intensity when the aeroplane flies overhead at an altitude of 2 km?

Solution. : Intensity of sound is given by formula

$$I = \frac{P}{4\,\pi R^2}$$

Where P = Acoustic pressure level

R = Radial distance

Here, for case – 1

$$I_1 = \frac{P}{4\,\pi R_1^2}$$

And for case – 2

$$I_2 = \frac{P}{4\,\pi R_2^2}$$

$$\therefore \frac{I_2}{I_1} = \frac{R_1^2}{R_2^2}$$

Now R_1 = 100 m, R_2 = 2000 m (given)

$$\therefore \frac{I_2}{I_1} = \frac{100^2}{2000^2} = \frac{1}{400}$$

or $\frac{I_1}{I_2}$ = 400 …(1)

Architectural Illumination Essential Notes

Important Terms

Black Body A "Perfect" emitter and absorber of radiation.

Brightness The subjective measurement of luminance.

Candela (cd) Unit of luminous intensity approximately equal to one candle power.

Chroma An index of colour saturation. Ranges from 0 for neutral grey to 10 for strong colours.

Chromatic Adaptation The eye adapting to changes in the colour of light sources.

Colour Rendering (of a light source) The ability of the source to render colours accurately. "Good colour rendering" suggests the source is rendering colours similar to the way daylight would.

Colour Rendering Index (CRI) (of a lamp) Is a measure of a lamp's colour rendering ability.

Colour Temperature (of a light source) The temperature of a black body which emits radiation of the same chromaticity as the light source being considered.

Correlated Colour Temperature (CCT)(of a light source) This is used to define the colour appearance of a light source. It is the temperature (K) of a black body which emits radiation nearest in chromaticity to the light source being considered. e.g. the CCT of a white fluorescent lamp is 3500 K.

Cylindrical Illuminance The mean illuminance on the surface of a small cylinder located at a specific point in a room. The axis is taken to be vertical unless stated otherwise. (Unit Lux)

Daylight Factor The illuminance at a point indoors, due to daylight, as a % of the horizontal illuminance outdoors, (direct sunlight is excluded from both values).

Diffuse Reflection Reflected light from a matt surface.

Diffuse Lighting "Soft" lighting in which the luminous flux comes from many directions, none of which predominates.

Direct Lighting Lighting in which most of the luminous flux reaches the working plane directly without reflection from other surfaces.

Directional Lighting Lighting on a task predominantly from one direction.

Disability Glare Glare which impairs vision.

Discomfort Glare Glare which causes discomfort.

Diversity The ratio of minimum to maximum illuminance (or luminance) over a specified area. (See also uniformity)

Downlighter Direct lighting luminaire which emits light only within a relatively small angle to the downward vertical.

Downward Light Output Ratio (DLOR) The ratio of downward light of a luminaire to its total light output. EFFICACY The ratio of lamp luminous flux divided by the power consumed by the lamp. The unit used is lumens per watt (lm/W). Where control gear is taken into account the unit becomes lumens per circuit watt.

Energy Management System (EMS) A computerised system for controlling energy use. FLICKER The visible modulation in light output due to the cyclic variation of a.c.

Flux Fraction Ratio (FFR) The ratio of upward luminous flux to downward luminous flux.

General Lighting Lighting illuminating a whole area.

Glare Discomfort or disability glare occurring when parts of the visual field are excessively bright.

Glare Index A quantification of discomfort glare in an installation.

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Consider a situation where the same amount of light strikes both a "dark" surface and a "bright" surface. The illuminance is the same in each case but due to the greater reflectance of the "bright" surface it now becomes a secondary source of light. Its luminance will therefore be much greater than that of the dark surface.

Luminance is measured in lumens emitted per sq.m. (not to be confused with Illuminance which is lumens received per sq. m.) and the unit used is "*Apostilb*" which is not a S.I. unit. The luminance may be thought of as the brightness of the surface. The term brightness is a subjective term however, whereas luminance is objective.

Luminance is usually be measured in candela per square metre, the illuminated surface being considered a secondary light source.

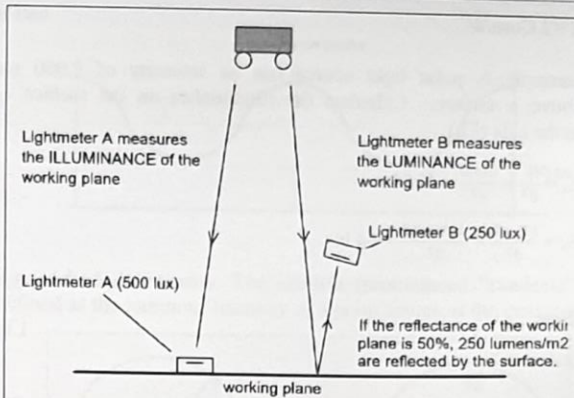


Figure: Experiment to illustrate the difference between Illuminance and Luminance

Note: 1cd/m^2 = 3.14 Apostilb = 3.14 lm/m^2

The luminance of a surface depends upon the amount of light arriving multiplied by the per unit reflectance R (p.u.).

The measure of luminance is most appropriate for flat diffuse surfaces that emit light evenly over the entire surface, such as a (computer) display. Luminance is a derived measure, expressed in Candela per square metre (*cd/m*^{2}). An alias for the unit *cd/m*^{2} (unofficial, but still commonly used) is "Nit".

Figure: Illuminance onto a surface, Luminance off the surface.

Example: The illuminance (E) on the working plane in Fig. 1.10 is 500 lux. The reflectance is 50%, calculate the luminance of the working plane.

L = E x R(p.u.) = 500 x .5 = 250 Apostilbs = 250 / 3.14 = 80 cd/m^2

Laws of Light

Rectilinear Propagation of light. This means that light travels in straight lines. It travels at 300,000 km/S and requires no medium for propagation.

Inverse Square Law: The area illuminated by the point light source increases in proportion to the square of the distance. It follows that the average illuminance would decrease by the same ratio.

$$E = \frac{I}{d^2}$$

where d = the distance between the source and the object.

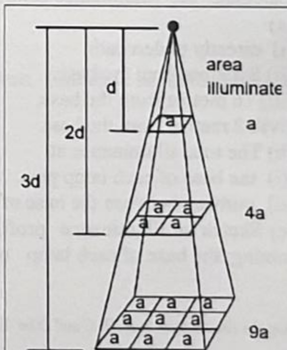


Figure: Inverse Square Law

In the example shown the illuminance reduces to a quarter of its original value when the distance is doubled. Similarly the illuminance reduces to one ninth of its original value when the distance away is tripled.

Cosine Law

When light does not fall normally on a surface, the area illuminated increases reducing the average illuminance by the same ratio. The figure shows light from a distant source striking surfaces AB and BC. The rays of incident light may be taken as parallel.

$$\frac{AB}{BC} = \cos\theta$$

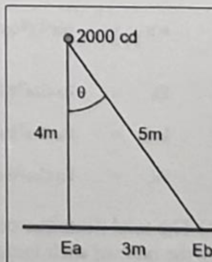


Figure: Cosine Law

Where θ = The angle between the incident light and the normal to the surface BC.

Therefore the average illuminance on a surface is given by the general formula:

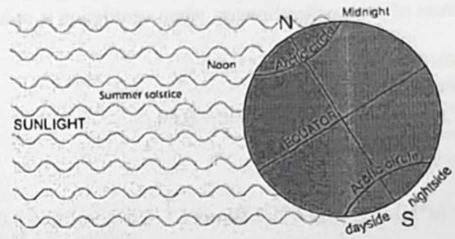
southern hemisphere. The opposite is the case on 21st March, when it is spring in the northern hemisphere and autumn in the southern hemisphere.

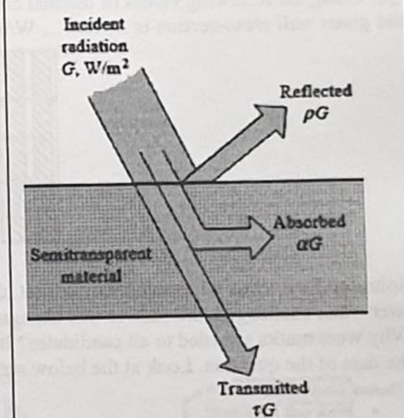
- Thus, you find that there are **days and nights and changes in the seasons because of the rotation and revolution of the earth respectively.**
- ***Rotation* ═══ *Days and Nights.***
- ***Revolution* ═══ *Seasons.***

Why regions beyond the Arctic circle receive sunlight all day long in summer?

- This is because of the tilt of the earth.
- Earth's axis at the north pole is tilted towards the sun in summer.
- So, the whole of Arctic region falls within the 'zone of illumination' all day long in summer.

(Source: https://www.pmfias.com/rotation-revolution-days-nights-seasons/)





GATE 2006: The absorption, reflection, and transmission of incident radiation by a semi-transparent material.

Absorptivity: $\alpha = \dfrac{\text{Absorbed radiation}}{\text{Incident radiation}} = \dfrac{G_{abs}}{G}, \quad 0 \le \alpha \le 1$

Reflectivity: $\rho = \dfrac{\text{Reflected radiation}}{\text{Incident radiation}} = \dfrac{G_{ref}}{G}, \quad 0 \le \rho \le 1$

Transmissivity: $\tau = \dfrac{\text{Transmitted radiation}}{\text{Incident radiation}} = \dfrac{G_{tr}}{G}, \quad 0 \le \tau \le 1$

In the above equation, if the conductivity (k) is divided by length (L) then it is called conductance.

So, $\frac{k}{L}$ = conductance (C)

$$q = \frac{k\,A\,\Delta T}{L}$$

Now let's solve the question with amended data:

Thermal conductivity -
- Brick wall 1.2 W/m °C
- Plastering 0.5 W/m °C

Surface conductance -
- Internal surface 8.0 W/m² °C
- External surface 9.5 W/m² °C

Thermal resistance -
- 50 mm wall cavity 0.17 m² °C/W

U-value is similar to conductance in concept. So, $\frac{k}{L}$ = conductance (C) ≡ U-value

We know,

$$\frac{1}{Uo} = \frac{1}{U_1} + \frac{1}{U_2} + \frac{1}{U_3} + \ldots$$

$$\frac{1}{Uo} = \frac{1}{\text{External surface}} + \frac{1}{\text{Internal Surface}} + \frac{1}{\text{Cavity}} + \frac{1}{\text{Plaster}} + \frac{1}{\text{Brickwork}}$$

$$\Rightarrow \frac{1}{Uo} = \frac{1}{8.0\ W/m^2\,°C} + \frac{1}{9.5\ W/m^2\,°C} + \frac{1}{\frac{1}{0.17\ m^2\,°C/W}} + \frac{1}{\frac{0.5\ W/m\,°C}{20\ mm}} + \frac{1}{\frac{1.2\ W/m\,°C}{200\ mm}}$$

$$\Rightarrow \frac{1}{Uo} = \frac{1}{8.0\ W/m^2\,°C} + \frac{1}{9.5\ W/m^2\,°C} + \frac{1}{5.99\ W/m^2\,°C} + \frac{1}{\frac{0.5\ W/m\,°C}{0.02\ m}} + \frac{1}{\frac{1.2\ W/m\,°C}{0.2\ m}}$$

$$\Rightarrow \frac{1}{Uo} = \frac{1}{8.0\ W/m^2\,°C} + \frac{1}{9.5\ W/m^2\,°C} + \frac{1}{5.99\ W/m^2\,°C} + \frac{1}{25\ W/m^2\,°C} + \frac{1}{6\ W/m^2\,°C}$$

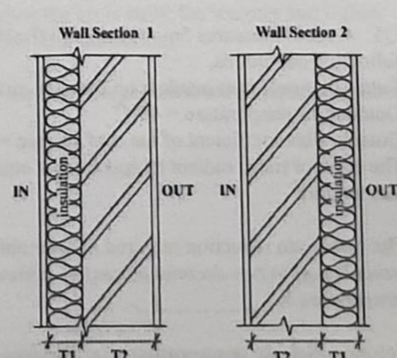
$$\Rightarrow \frac{1}{Uo} = 0.125\ (W/m^2\,°C)^{-1} + 0.105\ (W/m^2\,°C)^{-1} + 0.167\ (W/m^2\,°C)^{-1} + 0.040\ (W/m^2\,°C)^{-1} + 0.167\ (W/m^2\,°C)^{-1}$$

$$\Rightarrow \frac{1}{Uo} = 0.604\ (W/m^2\,°C)^{-1}$$

⇨ U = 1.65 W/m²°C Answer. This answer is in the range (that is *1.50 to 1.70*) of the official answer released for the first time!

GATE 2020

Q3. For the same thickness of material layers, relative position of insulation in the wall sections 1 and 2 shown below will have an impact on



(A) **Thermal Time Constant**
(B) Thermal Resistivity
(C) Thermal Transmittance
(D) Thermal Conductivity

Solution: The **Thermal Time Constant** indicates a time required for a thermistor to respond to a change in its ambient temperature. When the ambient temperature is changed from T1 to T2, the relationship between the time elapsed during the temperature change *t* (sec.) and the thermistor temperature T can be expressed by the following equation. [τ (tau in sec.) in the equation denotes the thermal time constant.]

$$T = (T_2 - T_1)\left(1 - \exp(-t/\tau)\right) + T_1$$

Please note that the above equation doesnot depend on the thickness of the material. But when we look at the formula of Thermal Resistivity, Thermal Transmittance & Thermal Conductivity , all depend on the thickness of the material.

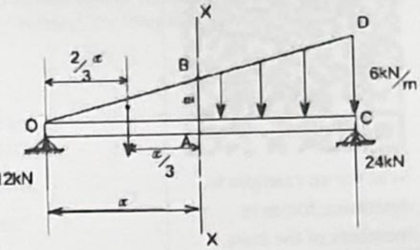
$$= \frac{0 + \frac{x}{2}}{2}$$

$$= \frac{x}{4} k \frac{N}{m}$$

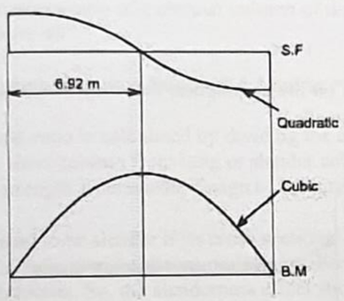
Therefore the total load over the length x would be

$$= \frac{x}{4} x \text{ kN}$$

$$= \frac{x^2}{4} \text{ kN}$$



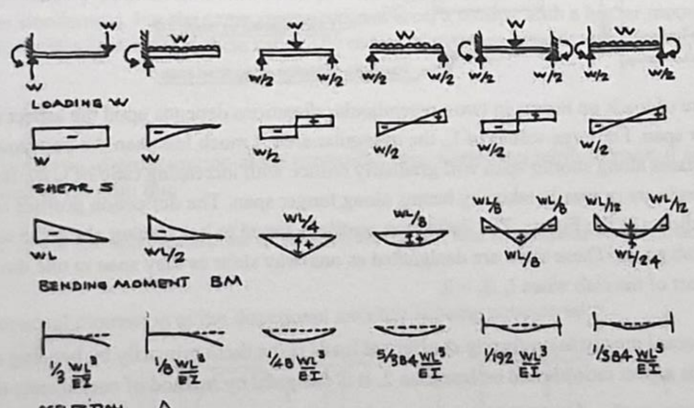
Now these loads will act through the centroid of the triangle OAB. i.e. at a distance 2/3 x from the left hand end.



Common Relationships

Load	0	Constant	Linear
Shear	Constant	Linear	Parabolic
Moment	Linear	Parabolic	Cubic

SHEAR BENDING AND DEFLECTION DIAGRAMS FOR SOME STANDARD CASES



RELATIVE STIFFNESSES ARE INVERSELY PROPORTIONAL TO MAX. DEFLECTION

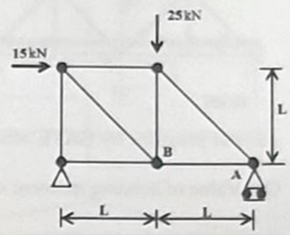
1 2.6 16 25.6 64 128

RELATIVE STRENGTHS ARE INVERSELY PROPORTIONAL TO MAX. BENDING MTS.

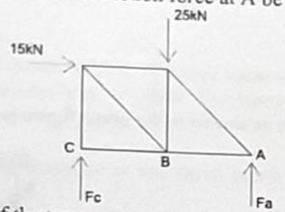
1 2 4 8 8 12

As per question, Bending Moment at x =3 is 36kN-m
Therefore, (4W/7)*x = 36
Putting x = 3 in the above equation, gives us W = 21kN Answer

Q4. A simple truss is shown in the figure below. The truss is loaded with horizontal and vertical force 15 kN and 25 kN, respectively. The force in the member AB will be ___________ kN.



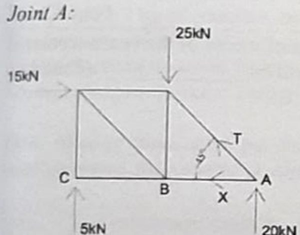
Solution: Our first aim should be to calculate reaction forces at support i.e. at A & C
Let the reaction force at C be Fc and reaction force at A be Fa



Sum of all vertical forces of the truss system must be zero.
So, Fa + Fc – 25kN = 0 ....(1)

Sum of moment at point C must be zero.
So, Fa*2L – 25kN*L – 15kN*L = 0
⇨ Fa = 20 kN

Joint A:



Sum of vertical forces at point A must be zero.
So, T*Sin45 + 20kN = 0
⇨ T = - 20kN/Sin45° ....(2)
Sum of horizontal force at point A must be zero.
Let the force in the member AB be X.
So, X – T*Cos45° = 0
⇨ X = 20 kN (Value of T is taken from equation (2)

So, the force in the member AB will be 20 kN Answer

GATE 2018

Q5. The compressive strength of M-25 concrete is
(A) 25 kg/sqm (B) 25 N/sqmm (C) 250 N/sqmm (D) 2.5 N/sqmm

Solution: Answer (B) 25 N/sqmm
According to Wikipedia, Compressive Strength of concrete is defined as the Characteristic strength of 150mm size concrete cubes tested at 28 days. But here in the question, the examiner is more interested whether you know the unit of the compressive strength a concrete or not. Option (A) and (B) may be a test for you. It is measured in Newton per square millimeter.

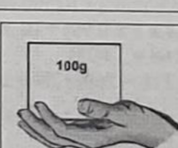


Figure: 100g in your hand is approximately equal to 1 Newton.

Q6. The live load and dead load in a three storeyed residential building, transferred through a single column, is 12 tons and 18 tons respectively. If the soil bearing capacity is 10 ton/sqm and the factor of safety is 1.5, the area of column footing is sqm (up to one decimal place).

Solution: Total load = (12+18)*1.5 = 45 ton

Bearing capacity = 10 ton/sqm
So, column footing area = (45 ton) / (10 ton/sqm) = 4.5 sqm Answer *(Official GATE answer varied from 4 to 5)*

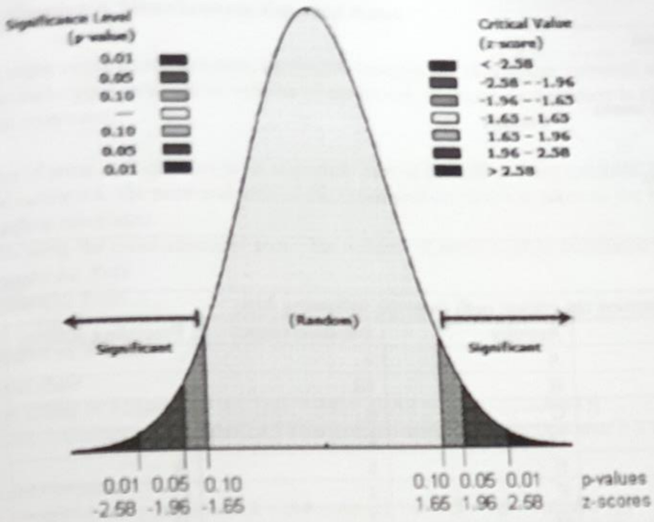


Figure: Z-score & P-value

GATE 1995

Q20. The optimistic (t_o) most likely (t_m) and permissible (t_p) times of activities on the critical path of a PERT network are given below.
Calculate the mean and the standard deviation of the path duration.

Activities on the critical path	t_o (days)	t_m (days)	t_p (days)
A	5	10	15
B	8	16	24

Solution: For an activity, mean = $(t_o+4t_m+t_p)/6$ and standard deviation = $(t_p - t_o)/6$

Activities on the critical path	t_o (days)	t_m (days)	t_p (days)	Mean $(t_o+4t_m+t_p)/6$	Standard Deviation, σ $(t_p - t_o)/6$	Variance, σ^2 Square of SD
A	5	10	15	10	1.67	2.79
B	8	16	24	16	2.27	5.15

We have already calculated σ for two activities – A & B. We now have to calculate standard deviation of the Critical Path. SD (standard deviation) of the Critical Path cannot be calculated by simply adding individual standard deviation σ. As per the Statistics, individual σ cannot be added together. In order to determine Critical Path SD, we have to first find Variance of the Critical Path.

Variance (Critical Path) = Variance(A) + Variance(B) = 2.79 + 5.15 = 7.94
As per the Statistics, σ can be determined by taking Square Root of Variance.
σ (Critical Path) = Square root of (Var(A) + Var(B)) = Square root of 7.94 = 2.82 Answer.

GATE 1994

Q21. The average completion time of the following construction activities are given below. As a construction manager for which activities you would like to maintain very strict schedule? Draw the network to justify your decision.

Activity	Average completion time (in weeks)
1-2	11
1-3	14
2-4	6
2-5	16
3-4	7
4-5	3

Q127. a) Explain the concept of relief displacement on aerial photography.

Illustration of deformation of an **aerial** image according to the distance from the nadir point, i.e. the centre of the image.

A vertical object (such as a building, for instance) will appear to be lying along a line radial to the image nadir point. This deformation is called **relief displacement**.

The image nadir point is the point located on the surface exactly below the perspective center.

This relief displacement underlie the following principles:

- Objects will tend to lean outward, i.e. be radially displaced.
- The taller the object, the greater the relief displacement.
- The further the object is from the principal point, the greater is the radial displacement.

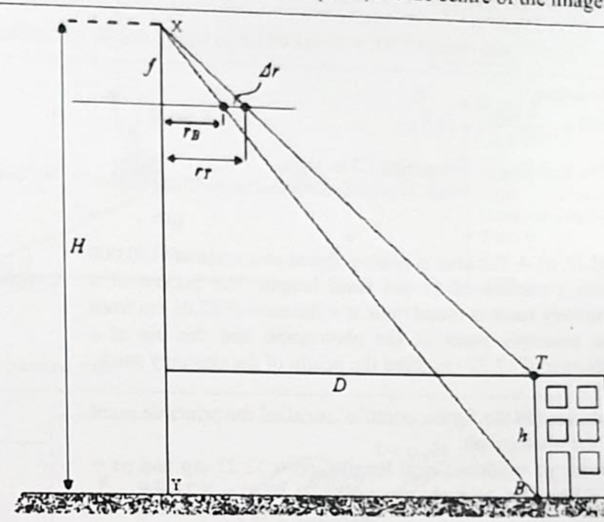


Figure: X is the perspective center, Y is the image nadir point

Relief Displacement: Calculating Height

We can derive an expression for the relationship between object height and relief displacement using the geometry depicted in following picture.

We may write two expressions for distance D in this figure, in terms of radial image distances rB and rT.

$$\frac{r_B}{D} = \frac{f}{H}, \quad D = \frac{H\, r_B}{f}$$

And

$$\frac{r_T}{D} = \frac{f}{H-h}, \quad D = \frac{r_T\,(H-h)}{f}$$

and set the two expressions for D equal to each other,

$$D = \frac{H\, r_B}{f} = \frac{r_T\,(H-h)}{f}$$

$$H\, r_T - h\, r_T - H\, r_B = 0$$

$$H(r_T - r_B) = h\, r_T$$

$$\frac{H \Delta r}{r_T} = h$$

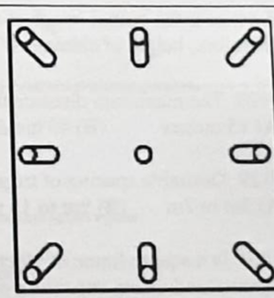
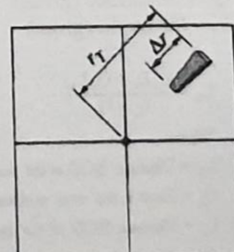


Figure: Illustration of deformation of an aerial image according to the distance from the nadir point, i.e. the centre of the image.

Source: Purdue University

The last equation tells us that the flying height above the base of the object (H) times the relief displacement in the photograph (Δr) divided by the radial distance from the principal point to the top of the object (rT) is equal to the height of the object (h).

Hence, if we know the flying height, we can calculate the height of any object in a photograph! The height of an object can be estimated from a single aerial photograph provided we have one auxiliary piece of information, the flying height.



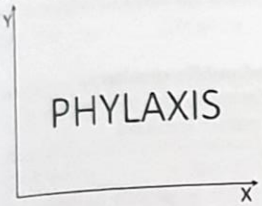
GATE Question Aptitude

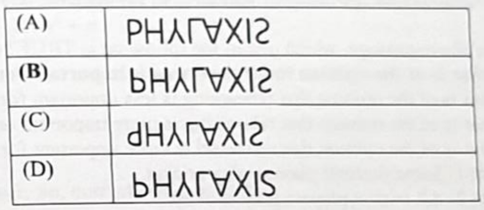
GATE 2021

Q1. (i) Arun and Aparna are here. (ii) Arun and Aparna is here.
(iii) Arun's families is here. (iv) Arun's family is here.

Which of the above sentences are grammatically CORRECT? (1 mark)
(A) (i) and (ii) **(B) (i) and (iv)** (C) (ii) and (iv) (D) (iii) and (iv)

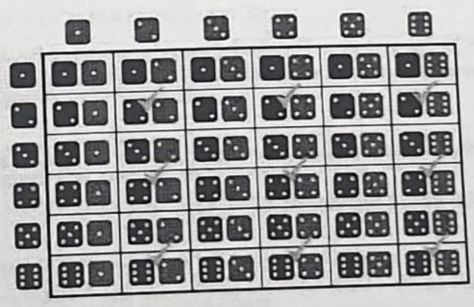
Q2. The mirror image of the below text about the x-axis is (1 mark)





Q3. Two identical cube shaped dice each with faces numbered 1 to 6 are rolled simultaneously. The probability that an even number is rolled out on each dice is: (A) 1/36 (B) 1/12 (C) 1/8 **(D) ¼** (1 mark)

Solution: Solution: Required probability = P(both are even) = P(first is even) * P(second is even) = (3/6)*(3/6) = (1/2)*(1/2) = **1/4 Answer**



Q4. ⊕and ⊙ are two operators on numbers p and q such that p ⊙ q = p − q, and p ⊕q = p x q.
Then, (9 ⊙ (6 ⊕ 7)) ⊙ (7 ⊕ (6 ⊙ 5)) =
(A) 40 (B) -26 (C) -33 **(D) -40** (1 mark)

Solution: [9-(6 X 7)] – [7 X 1] = - 33 – 7 = **- 40 Answer**

Q5. Four persons P, Q, R and S are to be seated in a row. R should not be seated at the second position from the left end of the row. The number of distinct seating arrangements possible is: (A) 6 (B) 9 **(C) 18** (D) 24 (1 mark)

So, required area = (Q) - (P) = 98/6 - 13/12 = 183/12 = **15.25**

Q46. The velocity V of a vehicle along a straight line is measured in m/s and plotted as shown with respect to time in seconds. At the end of the 7 seconds, how much will the odometer reading increase by (in m)? (2 marks)
(A) 0 (B) 3 (C) 4 (D) 5

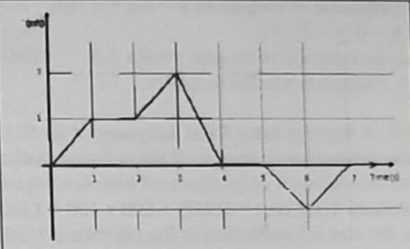


Figure: Odometer graph.

Solution: The odometer will read 5. (The area shaded under the graph). Odometer is an instrument for measuring the distance travelled by a wheeled vehicle. So, you have to just count the no. of squares made by triangles of the graph. Answer: (D) 5

GATE 2015

Q47. Solve the following:
Operators □, ◊ and → are defined by: a □ b = $\frac{a-b}{a+b}$; a ◊ b = $\frac{a+b}{a-b}$; a → b = ab.
Find the value of (66 □ 6) → (66 ◊ 6)
(A) -2 (B) -1 (C) 1 (D) 2

Solution: 66□6 = 66-6/66+6 = 60/74
66◊6 = 66+6/66-6 = 74/60
Therefore, (66□6) →(66◊6) = (60/74)x(74/60) = 1

Q48. If $\log_x(5/7) = -1/3$, then the value of x is
(A) 343/125 (B) 125/343 (C) -25/49 (D) -49/25

Solution: As we know,
$\log 10^2 = 2$, $\log 10^3 = 3$, $\log 10^4 = 4$ and so on.
[Actually, $\log_{10}(10^2) = 2$]
So, **$\log_x(5/7) = -1/3$**
→ $x^{-1/3} = 5/7$
→ $x^{1/3} = 7/5$
→ $(x^{1/3})^3 = (7/5)^3$
→ $x = (7/5)^3 = 343/125$

Q49. Fill in the missing value:

Solution: Missing value is 3

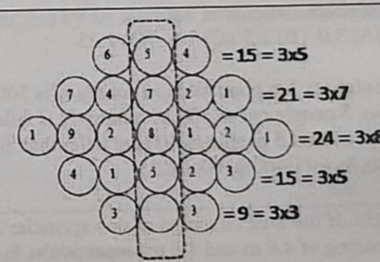


Figure: Solution of Q.No. 40

Q50. A cube of side 3 units is formed using a set of smaller cubes of side 1 unit. Find the proportion of the number of faces of the smaller cubes visible to those which are NOT visible.
(A) 1:4 (B) 1:3 (C) 1:2 (D) 2:3

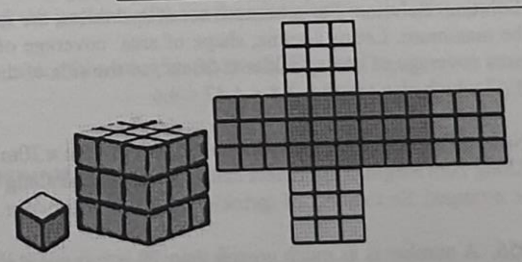


Figure: Rubik's Cube [Illustration for answer to Q. No.42]

Solution: Answer (C) Let us take an example of a Rubik's cube assuming each side of 3 units. A Rubik's cube is made up of 27 small cubes assuming each side of 1 unit. A cube has 9 faces. So total no. of faces in 27 cubes are 27x6=162. Out of which 6x9=54 are visible.
So NOT visible faces will be = 162-54= 108
Therefore, required ratio = 54/108= ½=1:2

GATE 2014

Q51. If $y = 5x^2 + 3$, then the tangent at x = 0, y = 3
(A) passes through x = 0, y = 0
(B) has a slope of +1
(C) is parallel to the x-axis
(D) has a slope of −1

Solution: y'= 10x (slope)
So, at x=0, y'=0

Coverpage Sketch:
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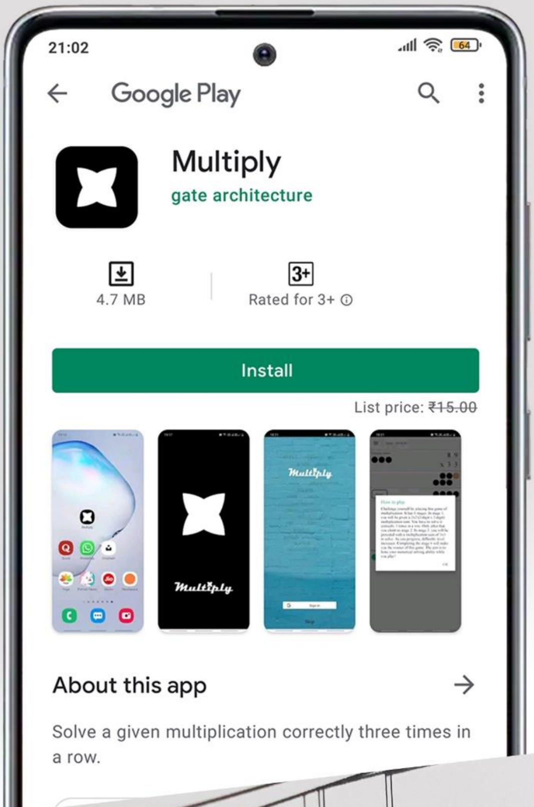

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