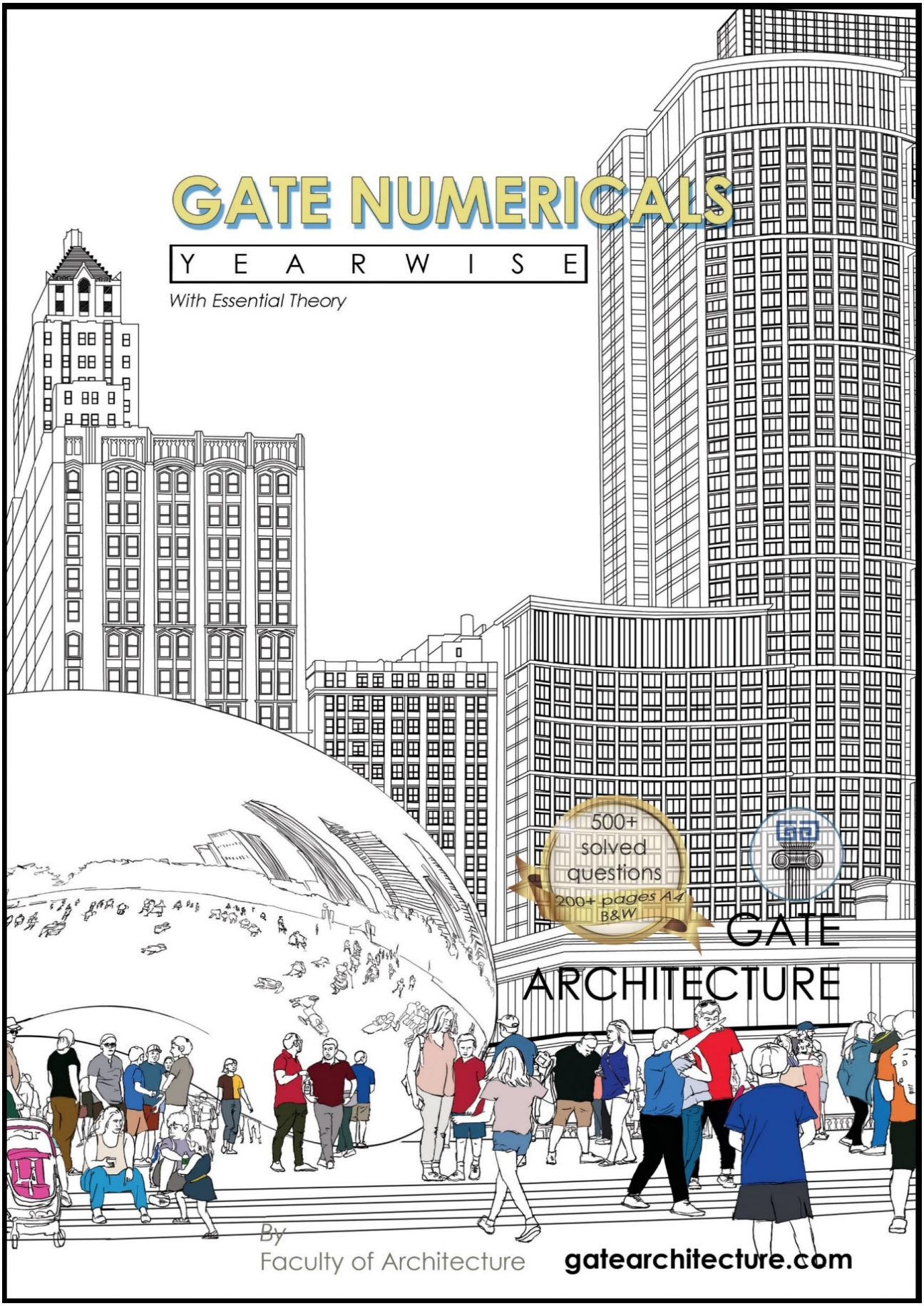
GATE NUMERICALS

YEARWISE

With Essential Theory



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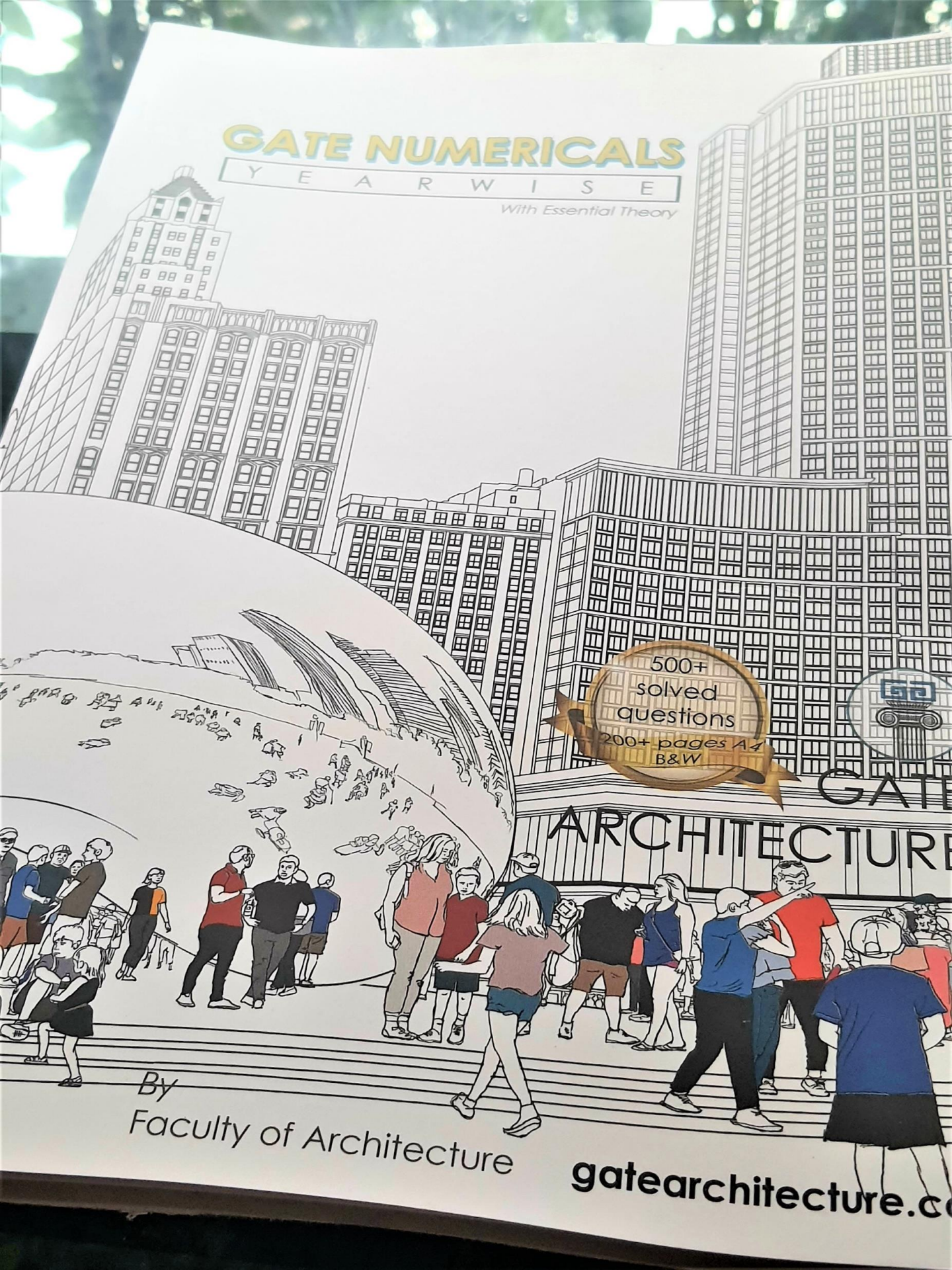

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GATE NUMERICALS

YEARWISE

6th Edition
for GATE 2022

31
YEARS
2021 - 1991

By
Faculty of Architecture

GATE ARCHITECTURE
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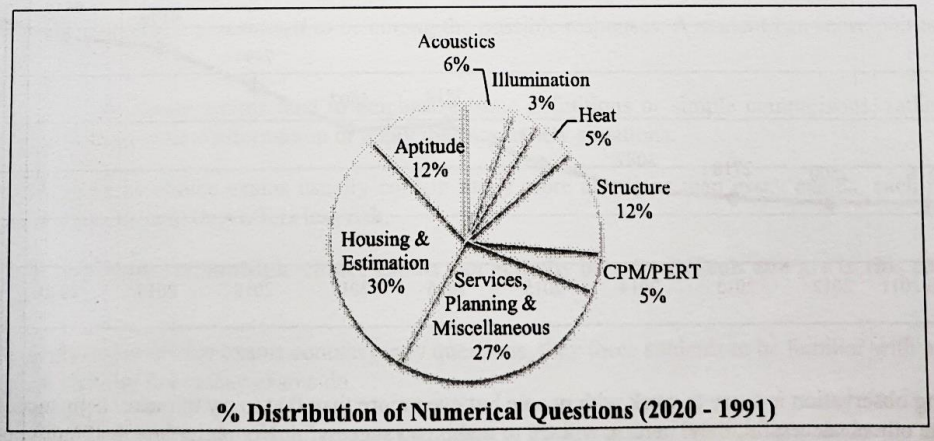
Contents:



% Distribution of Numerical Questions (2020 - 1991)

Preface

If you have already prepared for the exam, this book would be fruitful for you. This book is meant for the last stage preparation and add an edge to your preparation by reviewing sets of numerical questions asked in previous years. GATE 2021, there were total 18 numerical questions of out of total 65 questions. For most of the questions, no opti 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.

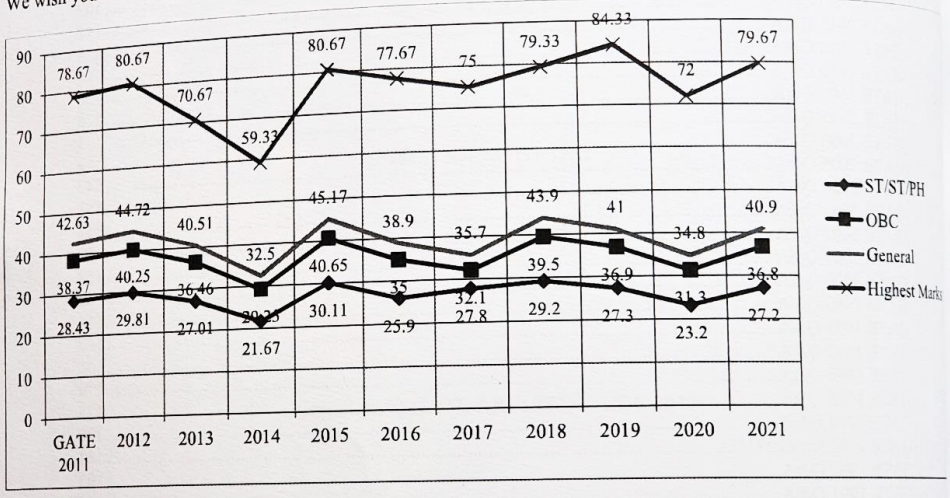
Answering an objective question has its own rule to follow when you have a doubt in choosing the right answer. For we have also attached expert opinion for handling objective question well.

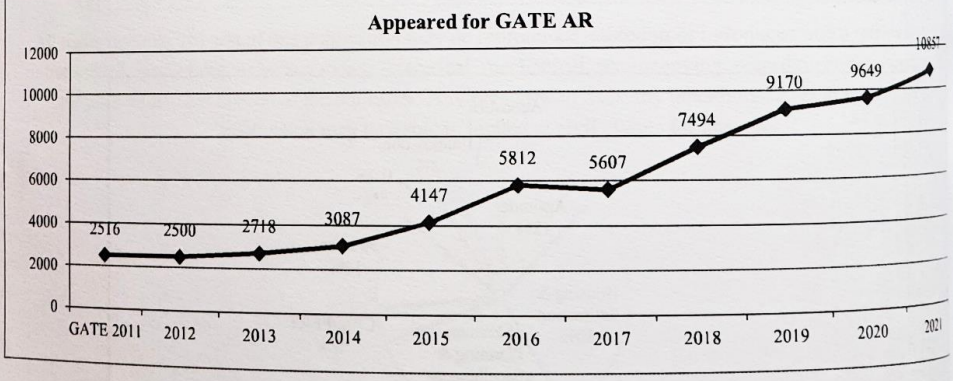
In this book, we have also provided basics of theories which are very essential before you solve a question.

Most of the questions have been solved. You are always welcome for your valuable suggestion and feedback about this book. If you find better contents or alternative solution, send us to gatearchitecture@gmail.com

We may add contents or solution by you in the next reprint or edition!

We wish you all the best for GATE 2022.





Fab Quote"

"The interesting observation is to try to work with people but even more than that to try to make them successful. If you try to make others successful, they, in turn, will try to make you successful. No matter how brilliant you are, no matter how good you are, no matter how hard you work, if you rely only on yourself and believe you don't need the help of others, you are sadly mistaken. If you engage everybody around you by helping them, they will help you, in turn. And you will be more successful than you ever dreamed of." – Former Director, Goldman Sachs

Tips & Tricks

Followings are resources. Plea followings are

Tips for solvin

Drawing the problem is mor

Example (GAT the room, in m Solution: Span

Having the sa For example, i For easy and c (A) 50Pa (B) answer.

Checking the numerical valu

Example: Area reinforcement,

Solution: Total Area of 8 mm

So, total no. of

becomes a dim rods', which d So, distance be *dividing 1000m convert 1m to*

Taking Multi Studying for a Multiple choic (called *distrac*

For many reas obvious reason

- The c guess.
- Many studen
- Becau lower

Despite these Consider that:

- Becau range
- Multi dates,

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; standards;

Section 2: Construction and Management

Project management techniques e.g. **PERT, CPM etc.; Estimation and Specification**; Professional practice and ethics; Form; 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 its 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, characters, 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 of 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; distribution system; Water harvesting systems**; Principles, Planning and Design of storm water drainage system; Sewerage 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;

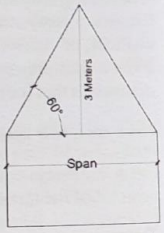
Part B2: Planning

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, Projects and Schemes.; Slums, Squatters and informal housing; Standards for housing and community facilities; Housing for special areas and needs;

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/tan 60°) = 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= 0.5m). 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 the correct answer, you should always write the numerical value with its unit.

Example: Area of the 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 = $\frac{335 sqmm}{50.24 sqmm}$ = 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 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 analyse 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.

given frequency is sounded. It enables us to classify a note as high or low and to distinguish a shrill sound from sound of the same intensity on the same instrument.) of the sound.

However, the sensitivity of the ear and the threshold audibility vary over wide ranges of frequency and intensity.

Hence the intensity level will be different at different frequencies even for the same value of I_0.

For measuring the intensity level a different unit called **phon** is used.

The measure of loudness in phons of any sound is equal to the intensity level in decibels of an equally loud pure tone of frequency 1000 Hz.

Hence Phon scale and decibel scale agree for a frequency of 1000 Hz but the two values differ at other frequencies.

Suppose the intensity level of a note of frequency 480 Hz is to be determined. A standard source of frequency 1000 Hz is sounded and the intensity of the standard source is adjusted so that it is equal to the loudness of the given note of frequency 480 Hz.

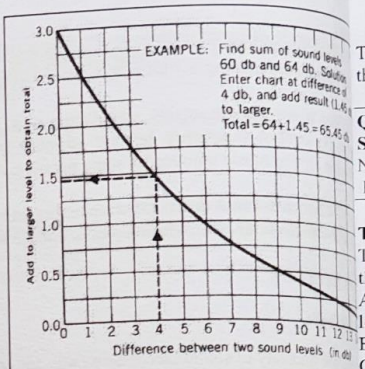


Figure: Remember this chart. It may save a lot of time to find the answer.

The intensity level of the standard source in decibels is numerically equal to the loudness of the given source in ph

Example: Calculate the change in intensity level when the intensity of sound increases 100 times its ori intensity.

Solution: Given,

Initial intensity = I_0
Final intensity = I

$$\frac{I}{I_0} = 100$$

Increase in intensity level = L

$$\therefore \quad L = 10 \log_{10}\left(\frac{I}{I_0}\right) \text{ (in dB)}$$

$$\therefore \quad \mathbf{L = 10 \log_{10} 100 = 20\ dB}$$ **Answer.**

Example: Find the intensity level in phons if 3000 Hz with intensity level of 70 dB produces the same loudne a standard source of frequency 1000 Hz at a intensity level 67 dB.

Solution : As the 3000 Hz source has the same loudness of standard source of 1000 Hz with 67 db, the intensity le the note of frequency **3000 Hz is 67 phons. Answer.**

Example : If Sound Source IL_1=60 dB and Sound Source IL_2=50dB, what is the total sound intensity?

Solution: Step **1. Convert dB (intensity level) to intensity (W/cm²)**

$IL_1=10 \log (I_1/I_0)$ $\quad$ $IL_2=10 \log (I_2/I_0)$
$60=10 \log(I_1/10^{-16})$ $\quad$ $50=10 \log(I_2/10^{-16})$
$6.0= \log(I_1/10^{-16})$ $\quad$ $5.0= \log(I_2/10^{-16})$
$10^6=I_1/10^{-16}$ $\quad$ $10^5=I_2/10^{-16}$
$I_1=10^{-10}$ $\quad$ $I_2=10^{-11}$

Step **2. Add intensity together**

$$\mathbf{I_1+I_2=1 \times 10^{-10} + 1 \times 10^{-11}}$$
$$\mathbf{I_{TOT}=11 \times 10^{-11}\ W/cm^2}$$

Step **3. Convert back to intensity level (dB)**

$$\mathbf{IL_{TOT}= 10 \text{ Log } (I_{TOT}/I_0)}$$
$$\mathbf{IL_{TOT}=10 \text{ Log } (11 \times 10^{-11})/10^{-16}}$$

$$\mathbf{IL_{TOT}=10 \text{ (Log } 11 + \text{Log } 10^5)}$$
$$\mathbf{IL_{TOT}=10 \text{ (1.04} + 5) = 60.4\ dB}$$

The above calculation is time consuming & requ thumb rule:

Question: Add two 60 dB sources
Solution: ΔdB = 0 {difference in two dB source Now, add 3 db to higher
IL=60+3=63 dB

The Inverse Square Law
The inverse square law is one of the fundamenta this is what the inverse square law describes:
A. Every time the physical distance between you lower (softer).
B. The opposite holds true too. As the distance i
C. There are exceptions, but they are not critical

Here is a very basic example: Start with a sound again at a distance of 6' and you will get a meas measurement will be 74 dB. Move from 12' to 2 move toward the source of the sound.
Critical Distance: In the glossary of audio termi reverberant sound have the same SPL (Sound Pr

Reverberation and Echo
Reverberation and echo are often perceived as t same thing; just perceived differently because o

Reverberation (reverb) is highly-diffused soun boundaries.
Echo is non-diffused, reflected sound energy, w

For spoken word, the human ear/brain system about 30-60 milliseconds (ms), as being one in nto one. The time arrival of the two is so close A. 60ms represents the upper limits of this inte liscrete echo.
3. Based on many factors, the integration time herefore intelligibility, are almost always the c 1. A repetitive echo is sometimes called "flutte etween one or more sets of parallel surfaces, 2. Flutter echo is most obvious and problemati naterials.
3. Absorption and/or diffusion can be used to r

Reverberation time :

Reverberation means the prolonged refl nothing but **persistence of sound even after t**
The time gap between the initial direc reverberation time.

- More precisely, the interval of time tak one millionth of its original value. (i.e.
- In a good auditorium it is necessary to
- When a source emits sound, the waves the direct waves reach his ears. Subseq note is continuously sounded, the inte

Illumination

Terms

Visible Light Transmission (VLT)
The percentage of visible light that is transmitted through the glazing assembly. This is the essential characteristic for daylighting calculations. A perfectly clear window would have a VLT of 100 percent. Most practical assemblies for architectural use are between 35 and 80 percent.

Solar Heat Gain Coefficient (SHGC)
The percentage of total solar radiant energy that is transmitted through the assembly. This is the essential characteristic for solar gain calculations. For ordinary windows without special coatings, the SHGC and the VLT are the same, sometimes called the shading coefficient (SC). However, with modern coated windows, the SHGC is almost always lower than the VLT. Such window systems are generically referred to as *low-emissivity* or *lowE* and are used in commercial construction.

Candela

The candela (unit cd) has its origin in the brightness of a "standard candle", but it has received a more precise definition in the International System of Units (SI) — and at that time the unit was also renamed from "candle" to "candela".

The candela measures the amount of light emitted in the range of a (three-dimensional) angular span. Since the luminous intensity is described in terms of an angle, the distance at which you measure this intensity is irrelevant. For ease of illustration, in the picture at the right the three dimensions have been flattened to two. In this picture, screen B would catch exactly the same amount of light rays (emitted from the light source) as screen A —provided that screen A were removed to not obscure screen B. This is because screen B covers the same angle as screen A.

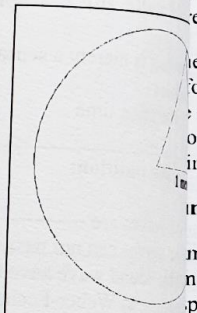


Figure: Creation of the angle.

The angular span for candela is expressed in steradian, a measure without unit (like radian for angles in a two-dimensional space). One steradian on a sphere with a radius of one metre gives a surface of one m^2. A full sphere measures 4π steradians.

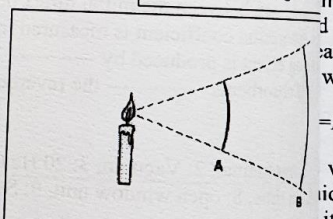


Figure: The candela measures the amount of light emitted in the range of a (three-dimensional) angular span. The luminous intensity is described in terms of an angle.

Lumen

If you look at LEDs, especially high-brightness LEDs, you may notice that the LEDs with a high luminous intensity (in candela or milli-candela, mcd) typically have a narrow apex angle. Similarly, LEDs with a wide apex angle typically have a relatively low luminous intensity. The same is true for halogen spots with reflector: those with a narrow-beam reflector have a higher rating in candela than the "floodlight" spots of the same power.

The cause for this relation is the total energy produced by the LED. LEDs of a specific class (for example, "high-brightness") all produce roughly the same amount of luminous energy. However, when a LED emits its total energy in a beam of narrow angle, the intensity will be greater (in the direction of that angle) than when *the same* energy had been emitted over a wide angle.

The lumen (unit lm) gives the total luminous flux of a light source by multiplying the intensity (in candela) by the angular span over which the light is emitted. With the symbol Φv for lumen, Iv for candela and Ω for the angular span in steradians, the relation is:

$$\Phi v = Iv \cdot \Omega$$

If a light source is isotropic (meaning: uniform in all directions), $\Phi v = 4\pi\, Iv$. This is because a sphere measures 4π steradians. See the topic on apex angles to get the three-dimensional angular span Ω from an opening angle.

$$= \frac{S_1 (a_C - a)}{0.161\ V}$$

$$\therefore \quad S_1 = \frac{0.161\ V}{a_C - a} \cdot \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

stituting various value

$$S_1 = \frac{0.161\ (20 \times 12 \times 12)}{0.5 - 0.1486} \left[\frac{1}{2} - \frac{1}{2.5}\right]$$

$$= 131.95\ m^2$$

arpet area required to reduce reverberation time up to 2.0 sec is 131.95 m^2 **Answer.**

---

mple: Calculate the reverberation time for the seminar hall with
No one inside.
50 persons inside
Full capacity of audience.
en that

Sr. No.	Surface	Area	Absorption co-efficient
1.	Carpet covering entire floor	(10 × 12) sqm	0.06
2.	False ceiling	(10 × 12) sqm	0.03
3.	Cushioned seats	100 Nos	1.00
4.	Walls covered with absorbent	346 sqm	0.2
5.	Audience occupying seats	–	0.46 / person
6.	Wooden door	(3 × 2) sqm	0.2

ution :

us calculate total absorption in the hall in case – 1 i.e. for empty hall

Absorption due to carpet	120 × 0.06	=	7.2
Absorption due to false ceiling	120 × 0.03	=	3.6
Absorption due to seats	100 × 1	=	100
Walls covered with absorbent	346 × 0.2	=	69.2
Wooden door	6 × 0.2	=	1.2
		$\therefore \sum aS$	= 181.2 ...(1)

Now Area of floor = Area of ceiling = (l × b)
= 120 sq.m
Area of wall + Area of door = 346 + 6 = 352
= 2 [(b × h) + (l × h)]

as $l \times b = 120\ m^2$
$\therefore$ let us take l = 12 m, b = 10 m
$\therefore$ 352 = 2 [(10 × h) + (12 × h)]
$\therefore$ h = 8 m ...(2)

hence volume V = 12 × 10 × 8 = 960 m^3 ...(3)

se 1 :

r empty hall

Reverberation time $T_1 = \frac{0.161\ V}{aS}$

$$= \frac{0.161 \times 960}{181.2}$$

T_1 = 0.85 sec **Answer.**

ase 2 :

ith occupancy of 50 persons.

$\therefore$ Absorption = aS + 50 × (0.46)

$\therefore$ Reverberation time $T_2 = \frac{0.161\ V}{aS + 50\ (0.46)}$

$$= \frac{0.161 \times 960}{181.2 + 23}$$

T_2 = 0.757 sec **Answer.**

ase 3 :

ith full occupancy. i.e. 100 persons here, the absorption is = aS + 100 (0.46)

$\therefore$ Reverberation time $T_3 = \frac{0.161\ V}{aS + 100\ (0.46)}$

balance is reached between the energy emitted per second by the source and energy lost or dissipated by
other materials.

- The resultant energy attains an average steady value and to the listener the intensity of sound appears to be
and constant.
- When intensity of sound falls below the minimum audibility level, the listener will not get the sound.

Absorption :

When a sound wave strikes a surface there are three possibilities.

(a) Part of energy is absorbed
(b) Part of it is transmitted
(c) Remaining energy is reflected

- The effectiveness of surface in absorbing sound energy is expressed by absorption coefficient denoted by

$$a = \frac{\text{Sound energy absorbed by the surface}}{\text{Total sound energy incident on the surface}}$$

- For the comparison of relative efficiencies of different absorbing material, it is necessary to select a stand
reference.
- Sabine selected a unit area of open window, as standard. For any open window the sound falling on it comp
passes out no reflection, and more importantly no absorption.
- Hence open window is an ideal absorber of the sound. The absorption coefficient is measured in open w
unit.

Sabine :

- The absorption coefficient of a material is defined as the reciprocal of its area which absorbs the same
energy as absorbed by unit area of open window.

Sabine's Formula

Sabine's formula is given by the following:

$$RT_{60} \cong \frac{0.161\text{s/m}\ V}{S_a}$$

RT_{60} is the reverberation time (to drop 60 dB)
V is the volume of the room
Sa is the total absorption in sabins

The sabin unit has the same dimension as area (e.g. m^2). A one square meter surface with an absorption coefficie
0.75 would be considered 0.75 sabins. The absorption coefficient has a range of 0 to 1, where a coefficient of 0
indicates none of the sound is absorbed, and a coefficient of 1 indicates that 100% of it is absorbed.

(Note that the factor 0.161 has the units seconds per meter; *dimensional analysis on the equation will yield a tim*
seconds as the volume is measured in cubic meters and sabins in square meters).

Example: Let us use this formula to calculate the reverberation time of a fictitious lecture hall. Let us say the hall
5-meter tall ceiling, is 20 meters wide and 10 meters deep. Let us also say that the absorption coefficient for the w
ceiling, and floors is 0.3.

To use Sabine's Formula, we'll first need the volume:

$$V = L{\times}W{\times}H = 10\text{m}{\times}20\text{m}{\times}5\text{m} = 1000\text{m}^3$$

The total absorption, in sabins, is the total area times the absorption coefficient. The total area in includes 4 walls
ceiling, and a floor, which when multiplied by the absorption coefficient gives us the total absorption in sabins:

$$S_a = \left((2{\times}50\text{m}^2) + (2{\times}100\text{m}^2) + 200\text{m}^2 + 200\text{m}^2\right){\times}0.3 = 210\ \text{sabins}$$

$$RT_{60} \cong \frac{0.161\text{s/m}\ 1000\text{m}^3}{210\ \text{sabins}} \cong 0.767\text{s}$$

Let us use the dimensions of the room above, but specify different absorption coefficients for the different surfaces
us say the tile floor has a coefficient of 0.01, the ceiling a coefficient of 0.5, and the 4 walls a coefficient of 0.2
The total absorption in sabins becomes:

$S_a = (0.01{\times}200\text{m}^2) + (0.5{\times}$

RT_{60}

This is very close to one seco

The sabin, named in honor of
absorbing material, and one
Sabine's 19th century work a
help engineers and architects

Noise

Noise is sound that is unwant

A. Noises can be either short
B. A room's signal-to-noise ra

Signal-to-noise (S/N) ratio:
total, aggregate noise package
A. A S/N ratio is most often e
SPL, and the noise measures
B. General industry guideline
comprehension. This is not m
minimum value that would re
C. Most acousticians and audi
possible.
D. Coherent early reflections

Noise Criteria (NC): The ter
points and values, which some
curve.
A. NC calculations and projec
re often the first line of defen

Sound Transmission Class (S
A. Many construction materia
various frequencies that might
B. Material STC ratings are no
ery relevant to controlling so

More Examples

Example: Calculate the chang
Solution : Given,
Initial intensity $= I_0$
Final intensity $= I$

$$\frac{I}{I_0} = 10^6$$

Increase in intensity level in d

$$L = 10 \log_{10}$$

$$\therefore \quad L = 60 \text{ d}$$

Example: A room has dimens
(a) the mean free path of
(b) the number of reflecti
walls of the room
Given : Velocity of sound in a
Solution :
(a) The mean free path of
between any two consecutive

Essential Notes

Acoustics

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

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

The branch of science which deals with the planning of a building to provide the best quality audible sound to the audience is termed as architectural acoustics or acoustics of the building.

ntensity Level (dB)

Bel & Decibell:

Whenever the intensity of sound increases by a factor of 10, the increase in the intensity is said to be 1 bel *(A unit named after Alexander Graham Bell, the inventor of telephone)*

Therefore dynamic range of audibility of the human ear is 12 bels or 120 dB. When the intensity increases by a factor of $10^{0.1}$, the increase in intensity is 0.1 bel or 1dB.

∴ in decibel

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

I_0: base intensity (10^{-16} W/cm^2, hearing threshold)
I: intensity (W/cm^2)

For the intensity level change = 1 dB

$$1 = 10 \log_{10} \left(\frac{I}{I_0}\right)$$

$$\therefore \frac{I}{I_0} = 1.26 \quad \ldots(1.4)$$

If $I = I_0$,
$L = 10 \log 1 = 0$

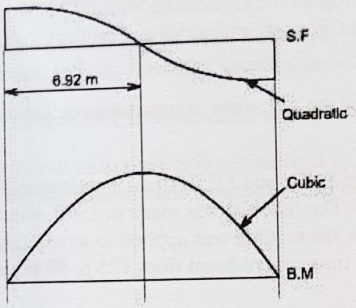
This represents the threshold of audibility.
It means that intensity level alters by 1dB when intensity of sound changes by 26%

Intensity levels of different sounds

Sr. No.	Sound	Intensity level (in db)
(1)	Threshold of hearing	0
(2)	Rustle of leaves	10
(3)	Whisper	15 – 20
(4)	Normal conversation	60 – 65
(5)	Heavy traffic	70 – 80
(6)	Thunder	100 – 110
(7)	Painful sound	130 and above

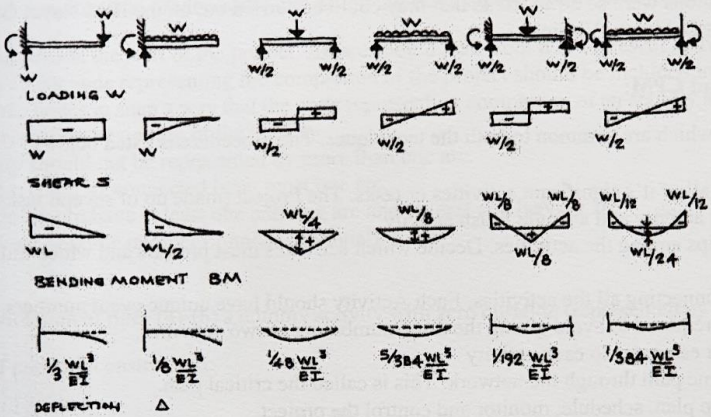
Phon: The intensity levels given in the above Table, refer to the loudness in decibels with the assumption that the threshold of audibility is the same irrespective of the pitch ***(Pitch is** a subjective sensation perceived when a tone of a*

Common Relationships



	0	Constant	Linear
Load			
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

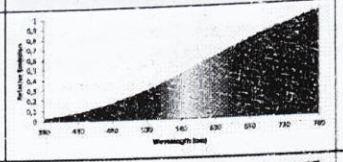
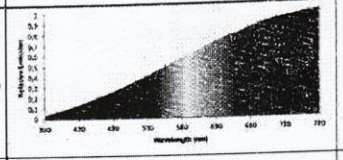
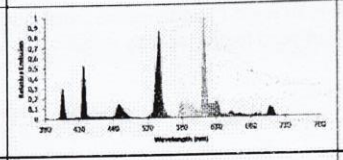
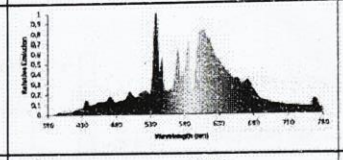
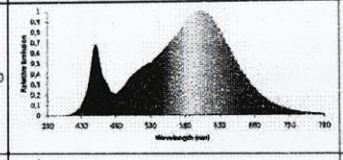
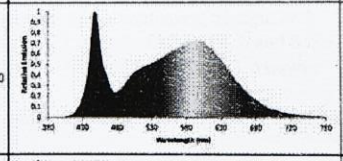
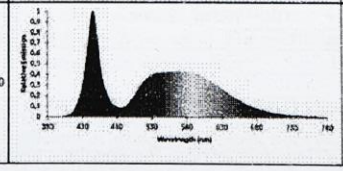
Description	Spectrum	Lamp or module luminous flux, measured (lm)	System luminous efficacy (lm/W)	Energy conversion efficiency	Theoretical maximum luminous efficacy (lm/W)
High voltage halogen, 120 W		2249	17.7	11.9	148.7
Low voltage halogen, 60 W		1535	25.6	15.4	166.3
Fluorescent lamp T 5, 54 W, 830		4184	81.6	23.7	344.4
Metal halide lamp, 70 W, 830		7912	99.2	31.5	314.5
LED, 35 W, 830		4739	138.6	42.3	327.6
LED, 35 W, 840		4806	139.3	43.7	318.8
LED, 16 W, 750		2436	150.5		309

Figure: The table shows observed and the theoretical maximum luminous efficacy of different spectra.

From the table we can see that the typical spectrum of a warm white LED achieves a theoretical module luminous efficacy of approx. 320 lm/W. However, since the assumption is that there is loss-free conversion of physical radiated power into the wavelengths of the spectrum, then the actual realisable module luminous efficacy is much smaller. In future it may be possible to achieve system luminous efficacy in the range of 200–250 lm/ W.

In addition, the overview shows energy conversion efficiency of the lamps examined. The energy conversion efficiency describes how much of the power is converted into visible light. In this respect efficient LEDs are clearly well ahead of conventional lamps. While energy conversion efficiency of incandescent lamps, for example, is between 10% and 20%, very efficient LEDs at present achieve values between 40% and 50%. Nevertheless, this is still only 40 – 50%, so 50% to 60% of the power is lost as heat. (Source: https://www.dial.de/en/blog/article/efficiency-of-leds-the-highest-luminous-efficacy-of-a-white-led/)

The question could be solved with following assumptions:
Assumption 1: Illumination level is uniform throughout the Cricket field and is equal to 750 Lux.
Assumption 2: There is no illumination outside the Cricket field due to floodlight.

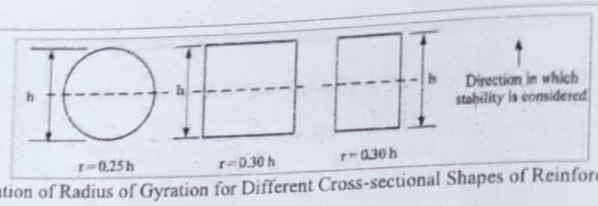


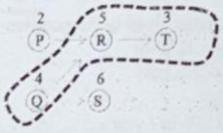
Figure: Approximate Estimation of Radius of Gyration for Different Cross-sectional Shapes of Reinforced Concrete Column

(Source: https://theconstructor.org/structural-engg/slenderness-ratio-column-calculate/494767/)

Q19. A construction project consists of following five activities. The immediate successor activity relationship and duration of each activity are mentioned in the table below. The total duration of the project is ..... weeks. [in integer] *Answer: 12*

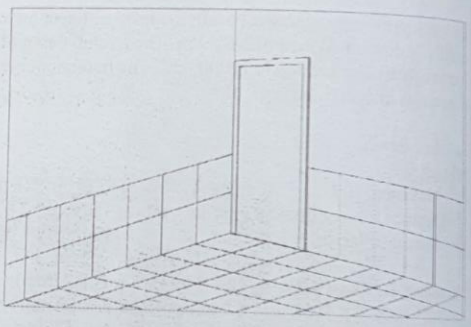
Activity	*Immediate Successor Activity*	*Duration (Weeks)*
P	R	2
Q	R and S	4
R	T	5
S	-	6
T	-	3

Solution:



The longest path is Q > R > T.
Therefore, total duration of the project is 4 + 5 +3 = 12 Weeks Answer

Q20. It is proposed to have ceramic tile flooring in a room having internal clear dimension of 1.8 m × 2.4 m. Tile sizes are 300 mm × 300 mm. The door opening is 900 mm and the door is flushed with the internal face of the wall. The height of skirting is 600 mm. The number of ceramic tiles required for internal flooring and skirting is _____. [in integer] *Answer: 98*

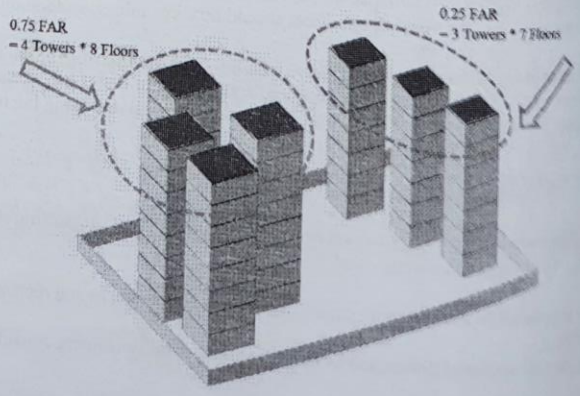


Solution: Number of tiles for internal flooring = Floor Area / Tile Area = (1.8 m x 2.4 m) / (0.3 m 0.3 m) = 48 Tiles
Number of tiles for skirting = Skirting Area / Tile Area = [(perimeter * 0.6 m) – door width* 0.6 m)] / (0.3 m * 0.3 m)
= [(2*(1.8m + 2.4 m) * 0.6 m) – 0.9 * 0.6 m)] / 0.09 m^2 = [(8.4 m* 0.6 m) – 0.9 * 0.6 m)] / 0.09 m^2
= 5.04 m^2 – 0.54 m^2 / 0.09 m^2 = 4.5 / 0.09 = 50 Tiles
Therefore, total number of tiles = 48 + 50 = 98 Tiles Answer

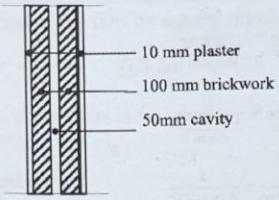
Q21. In a housing project, 75% of the permissible FAR was utilised after constructing four numbers eight storey MIG towers with identical floor area of 400 sqm. If three numbers seven storey LIG towers with identical floor area are built utilising the remaining FAR, the floor area of each LIG tower is ..... sqm. [round off to 2 decimal places] *Answer: 202 to 204 (Marks to all)*

Solution: First let us understand why at first, the GATE official released the answer in the range of 202 to 204 but later when challenged, the answer was changed. Marks was awarded to all.
Why were marks awarded to all candidates? It was because the question was wrong. It was essentially a small error in the form of grammatical mistake. Look at the following wordings:
'four numbers eight storey MIG towers' &
'three numbers seven storey LIG towers'
It should be 'four numbers **of** eight storey MIG towers' & 'three numbers seven **of** storey LIG towers'
Also, in the question the wordings 'the floor area of each LIG tower' implies that it is asking sum of all the floors area of a LIG tower. If the wordings were 'the floor area of each LIG **flat**' then the question could be solved as below:

Now, let's solve the question after the amendments.
Let us assume that total built up area = A m^2
So, 75% of A = (4 towers) * (8 storey) * 400 m^2
⇨ A = 12800 / 0.75 = 17067 m^2
As per question,
25% of A = (3 towers) * (7 storey) * (Area of each LIG flat)
⇨ 25% of 17067 m^2 = (3 towers) * (7 storey) * (Area of each LIG flat)
⇨ 4266.75 m^2 = 12 * (Area of each LIG flat)
⇨ Area of each LIG flat = 203.18 m^2 Answer. This answer is in the range (that is *202 to 204*) of the official answer released for the first time!



Q22. Using the following values of thermal conductance, surface conductance and thermal resistance, the U value across the given wall cross-section is ..... W/m² °C. [round off to 2 decimal places] *Answer: 1.50 to 1.70 (Marks to all)*



Thermal conductance -
- 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

Solution: First let us understand why at first, the GATE official released the answer in the range of 1.50 to 1.70 but later when challenged, the answer was changed. Marks was awarded to all.
Why were marks awarded to all candidates? It was because the question was wrong. It was essentially a small error in the data of the question. Look at the below screenshot:

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

The unit of conductance is not same at two places. At one place, it is W/m°C and at another place it is W/m²°C.

W/m°C is a unit of Thermal Conductivity.
W/m²°C is a unit of Thermal Conductance.

Concept of Conductivity and Conductance

Thermal Conductivity is a material's ability to conduct heat.
Each material has a characteristic rate at which heat will flow through it. The faster heat flows through a material, the more conductive it is. It is represented by letter ***k***.

It is used in the follow equation:

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

where,
q = the resultant heat flow (Watts)
k = the thermal conductivity of the material (W/mK).
A = the surface area through which the heat flows (m²)
ΔT = the temperature difference between the warm and cold sides of the material (K), and
L = the thickness / length of the material (m)

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,

$$\frac{1}{U_o} = \frac{1}{U_1} + \frac{1}{U_2} + \frac{1}{U_3} + \dots$$

. If surface conductance of external surface is 20 W/m²°C, absorbance of the surface is 0.66 and U value of the wall is 1.2 ²°C, the solar gain factor of a wall is …….. [round off to 2 decimal places] *Answer: 0.03 to 0.05*

r Gain Factor (θ)
solar gain factor is defined as the heat flow rate through the construction due to solar radiation, expressed as a fraction of the lent solar radiation. Its value should not exceed 0.04 in warm-humid climates or 0.03 in the hot-dry season of composite ates, when ventilation is reduced.

r Gain Factor (θ) = (a*U) / f_o
ere,
bsorbance of the surface = 0.66
U-value = 1.2 W/m²°C
20 W/m²°C

a*U) / f_o = (0.66*1.2 W/m²°C) / 20 W/m²°C = 0.0396 Answer

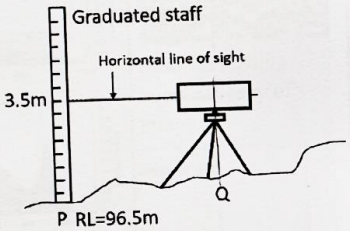
. The initial cost of a property is INR 4,00,000 and its future life is 30 years. Considering the scrap value as 10% of its initial and rate of interest as 5%, the sinking fund (deposited at the end of year) for the property is INR……. [round off to 2 mal places] *Answer: 5405 to 5422*

ution: Amount to be deposited at the end of 30 years = 400000 – 10% = 360000 = $P * \frac{(1+r)^n-1}{r} = P * \frac{(1+0.05)^{30}-1}{0.05}$

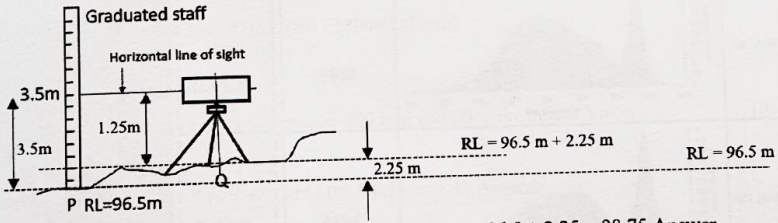
$00000 * \frac{1.05^{30}-1}{0.05} = P * 66.44$

⇨ P = 5418.42 Answer

. Reading in the staff stationed at P measured by a dumpy level is 3.5 m. The py level is stationed at Q. The Reference Level (RL) at point P is 96.5 m and the ght of the dumpy level is 1.25 m. The RL at point Q is …… m. [round off to cimal places] *Answer: 98.75 to 98.75*



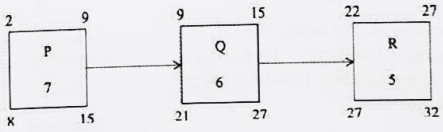
ution: If we subtract the height of dumpy level i.e. 1.25 m from the reading of py level i.e. 3.5 m, we get the height H that above RL at point P. So, H = 3.5 – 1.25 25 m



shown in the figure, point Q is above point P. Therefore, RL at point Q = 96.5 + 2.25 = 98.75 Answer

5. A circular cricket field of 180 m diameter is illuminated by four floodlight towers. The floodlight towers are equally spaced ng the perimeter of the field. The height of the floodlight tower is 48 m. Using 'Inverse Square Law', the illumination level at center of the field is found as 750 Lux. Each tower is comprising 50 lamps. The rating of each lamp is 700 Watt. The efficacy ach lamp is ……. Lumen /Watt. [round off to 2 decimal places] *Answer: 117 to 119 or 1483 to 1496*

ution: It seems, the question needs more data. Question could not be solved for the answer that could fit in the official GATE wer range of 117 to 119 or 1483 to 1496.
answer range 1483 to 1496 Lumen/Watt is never possible.
greatest luminous efficacy which can theoretically be achieved is 683 lm/W. However, in practice this value cannot be ched, since, if this were so, it would mean that 1 Watt of physical radiant power can be converted loss-free into visible light.



tion: Independent Float
of succeeding activity – LF of preceding - Duration of the activity of which Independent float is to be counted
of R – LF of P – Duration of Activity Q
– 15 – 6
Answer

Scan for pdf on Total, Free, Independent & Interfering float.

Scan for video lecture on Total float & Free float.

Scan for video lecture on Independent float

Figure: Scan for explanation on YouTube for Independent Float

. A population of 2500 persons requires a minimum area of 3000 m^2 for primary schools. For the population in four erent sectors given in the table below, the **Sector** having maximum shortage of school area per person is _____.

Sector	Population	Number of existing schools	Existing area of each school (m^2)
1	20000	5	2000
2	15000	4	4500
3	12500	2	2500
4	10000	4	1500

ution:

ctor	Population A	No. of existing school B	No. of required school C	Existing area of each school D	Combined Available Area of all schools B * D = K	Total Area required for school C * 3000 = E	Shortage E – K = S	Shortage School area per person S/A
	20000	5	20000/2500 = 8	2000	10000	8 * 3000 = 24000	14000	**0.7**
	15000	4	15000/2500 = 6	4500	4 * 4500 = 18000	6 * 3000 = 18000	0	**0**
	12500	2	12500/2500 = 5	2500	2 * 2500 = 5000	5 * 3000 = 15000	10000	**0.8**
	10000	4	10000/2500 = 4	1500	4 * 1500 = 6000	4 * 3000 = 12000	6000	**0.6**

swer: Sector 3

1. A basement wall resists lateral pressure exerted by soil and water. The soil pressure amounts to 4.5 kN/m^2 for ry metre of depth below Ground Level (GL). The sub- soil water level is 1.0 m below GL and hydrostatic pressure water is 9.8 kN /m^2 for every metre of depth below GL. The total lateral pressure (in kN/m^2, *rounded off to decimal place)* exerted on the wall 2 m below GL is _____.

ıox

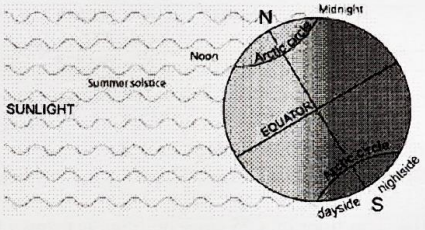
On **21st March** and **September 23rd**, direct rays of the sun fall on the equator. At this position, neither of the poles is tilted towards the sun; so, the whole earth experiences equal days and equal nights. This is called an equinox.

On 23rd September, it is **autumn season [season after summer and before the beginning of winter]** in the northern hemisphere and **spring season [season after winter and before the beginning of summer]** in the 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.

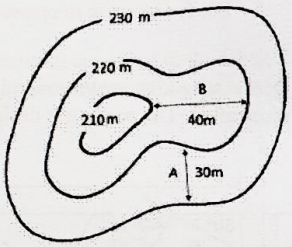


regions beyond the Arctic circle receive sunlight all day long in
ıer?

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.

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

In the given contour map, the angle at 'A' (in degrees. *rounded off to two al places)* is _____.



ion: $\text{Tan}\theta = \frac{Perpendicular}{Base} = \frac{Contour\ Height}{Distance\ between\ Countour} = \frac{10}{30} = \frac{1}{3}$

$\Rightarrow \theta = \text{Tan}^{-1}\frac{1}{3} = 18.43$ Answer

ial GATE answer range: 18.2 to 18.5

Average density of a highway is 25 vehicles per km. Average volume of the cles on the highway is 520 vehicles per hour. The mean speed (in km/hour, *ded off to one decimal place)* is _____.

tion: Mean Speed $= \frac{Distance}{Time} = \frac{520\ vehicles\ per\ hour}{25\ vehicles\ per\ km} = \frac{520\ \cancel{vehicles}\ per\ hour}{25\ \cancel{vehicles}\ per\ km} = \frac{\frac{520}{hour}}{\frac{25}{km}} = \frac{520km}{25\ hour} = 20.8$ km/hr Answer

ial GATE answer range: 20.8 to 20.8

One hectare is equal to
(A) 4048 m^2 (B) 4000 m^2 (C) 10000 m^2 (D) 4840 m^2

tion: One hectare = 100m x 100m = 10000m^2 Answer (C)

Assuming that the population growth trend given in the table will continue, the population (in persons) for the 2031 will be _____.

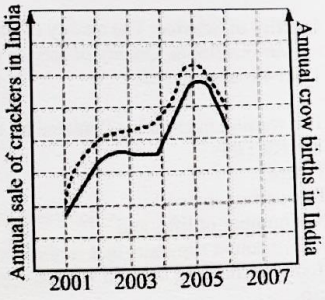
S.No.	Year	Population (in persons)
1	1981	1,30,440
2	1991	1,69,572
3	2001	2,20,444
4	2011	2,86,577

ıtion: We can predict population only if there is some pattern.

e, we need to find the pattern. Usually population grows in two patterns: Arithmetic progression or Geometric gression.

$/x^2 - 2 = (+1)$
$/x^2 = 3$
ing above equation,
$/x^4 + 2 = 9$
$/x^4 = 7$ **Answer**

n a detailed study of annual crow births in India, it was found that there was relatively no growth during the
d 2002 to 2004 and a sudden spike from 2004 to 2005. In another unrelated study, it was found that the revenue
cracker sales in India which remained fairly flat from 2002 to 2004, saw a sudden spike in 2005 before declining
in 2006. The solid line in the graph below refers to annual sale of
ers and the dashed line refers to the annual crow births in India. Choose
ost appropriate inference from the above data.
here is a strong correlation between crow birth and cracker sales.
racker usage increases crow birth rate.
cracker sale declines, crow birth will decline.
ncreased birth rate of crows will cause an increase in the sale of
ers.



ion: Option (B) is incorrect as there is no any factor mentioned in the
graph that could affect the crow birth rate due to uses of cracker. For the
reason options (C) and (D) are invalid. So, the correct option is (A).

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

s: Compressive Strength of concrete is defined as the Characteristic strength of
nm size concrete cubes tested at 28 days. But here in the question, the examiner is
interested whether you know the unit of the compressive strength a concrete or not.
on (A) and (B) may be a test for you. It is measured in Newton per square millimeter.

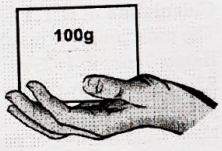


Figure: 100g in your hand is approximately equal to 1 Newton.

) In Critical Path Method (CPM) for time scheduling, 'forward pass calculation' is
ed out for determining
Late start and early finish time (B) Early start and early finish time
Late start and late finish time (D) Early start and late finish time

wer: The correct answer is option (B) Early start and early finish time, For more details, see theory notes.

1 As per the National Building Code of India 2016, the minimum turning radius (in metres) required for fire tender
ement is
8.0 (B) 8.5 (C) 9.0 (D) 9.5

wer: (C) 9.0 As per the National Building Code of India 2016, the minimum turning radius (in metres) required for
tender movement is 9.0 m

2 A room of 3m × 3m × 3m has a reverberation time of 0.8 sec. Using Sabine's method, the total absorption in the
n is _____ sabin (up to one decimal place).

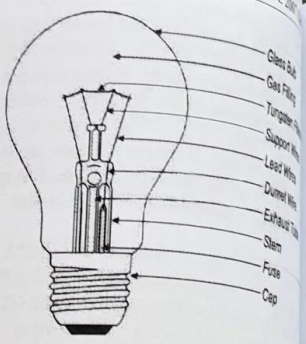
ution: $RT_{60} = 0.16V/A$
sec = $0.16*(3x3x3m^3)/A$
A = **5.4 sabin Answer** *(Official GATE answer varies from 5.3 to 5.7)*

3 A 25 storeyed building has 5 lifts. The resulting waiting time is 35 sec and 'Return Travel Time' is 175 sec. The
nber of lifts required for reducing waiting time to 25 sec, without increasing the lift speed, is _____.

ution: Number of lifts = 175/25 = 7 Answer

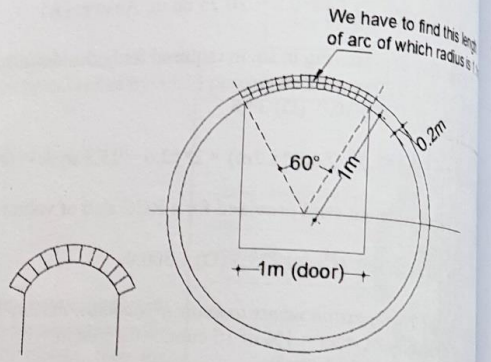
tes: Handling Capacity & Round Trip Time (RTT)

Notes: An **incandescent lamp** is an electric light with a wire filament heated to such a high temperature that it glows with visible light (incandescence). The filament, heated by passing an electric current through it, is protected from oxidation with a glass or fused quartz bulb that is filled with inert gas or evacuated. Answer (A)



16. A 60◦ segmental arch is provided over a door of 1.0 m width. The wall thickness is 30 cm and the arch thickness is 20 cm. The mean length of the arch in metres is
(A) 1.00 (B) 1.15 (C) 1.20 (D) 1.30

Solution: Length of arc $= \frac{60^0}{360^0}(2\pi r) = \frac{1}{6}(2\pi r) = \frac{1}{6}(2\pi 1.1) = 1.15\text{m}$ Answer (B)



17. The slenderness ratio for a cantilever prismatic column of length L with a circular cross section having radius r is
(A) L / r (B) 2L / r (C) 3L / r (D) 4L / r

Notes; **Slenderness ratio** is the ratio of the length of a column and the least radius of gyration of its cross section. Often denoted by lambda. It is used extensively for finding out the design load as well as in classifying various columns in short/intermediate/long. Answer (B)

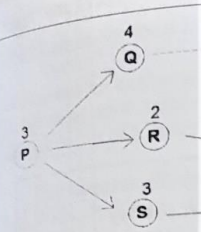
Common Data Questions:

Common Data for Questions 18, 19, 20: The continuous utility data for a construction project is as follows:

Activity	Duration (days)		
	Normal	Crash	Immediate Predecessors
P	3	3	
Q	4	4	-
R	2	1	P
S	3	3	P
T	0	0	P
U	6	5	Q
V	4	2	R, T
			S

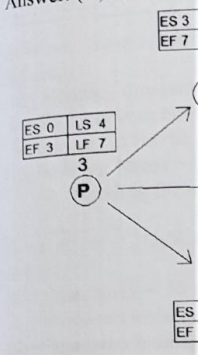
18. The normal project time for the given network is
(A) 11 (B) 12 (C) 13 (D) 14

Answer: 13 Days Answer (C)



19. For the all-normal s
(A) 1, 1 (B) 0, 3 (C) 3

Answer: (D) 3, 0



Notes: **Total Float**
Total float is what ma
Total float is the amo
path, the total float is
Total float is often kn
You can calculate the
– Early Start date), or
Free Float
Now we come to free
Free float is the amou
You can calculate th
activity (ES of next A
Keep in mind that if t

20. While crashing th
(A) R **(B) U** (C) T

Common Data for Q
A room measuring 1
utilization is 0.75 an

21. The lumen outpu
(A) 12,000 (B) 16,6

Solution: Lux = lum
So, No. of lumen re
Considering efficien
Therefore, L*0.75*(
Hence, output requi

22. The depreciatio
(A) 0.6 (B) 1.25 (

a → b = ab.

on: Maximum shear stress in a beam section = 3/2(F/A).
ıear Force & A = cross-sectional Area

laximum shear
[(600x1000N)/(300mmx500mm)]
/mm²

a 50 meter section of a waste water pipe. if the gradient is 1
, then the fall in millimeter is _____.

ion: 1:80 => for 80m , fall is 1m
So, for 1m, fall will be 1/80m
So, for 50m, fall will be 1/80x50 = 0.625m = 625mm

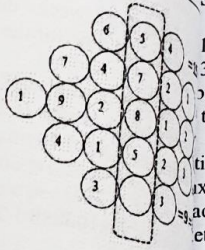
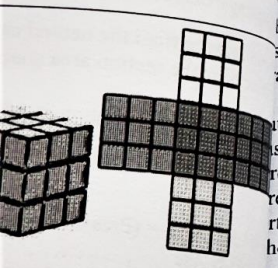


Figure: Solution of Q.No.3

15 meter long and 3 meter wide driveway needs to be paved
300 mm X 300 mm square Tiles. If each packet contains 30
ers of tiles, then the number of packets to be procured to
the whole area is_____.

tion: Area covered by each tile is 300mmx300mm =
ıx0.3m = 0.09sqm
ach packet contains 30 numbers of tiles, area covered by each
et = 0.09x30 = 2.7sqm

l area of the roadways = 15mx3m = 45sqm
ıo. of required packets= 45sqm/2.7sqm = 16.67 = 17 packets



Cube [Illustration for answer to Q

he housing stock of a town has total number of 9090 dwelling
s. Present population of the town is 45,450. Assuming an
age household size of 4.5, the housing shortage in percentage is_____.

ıtion: Present Population = 45,450
sehold size = 4.5
required no of dwelling units = 45,450/4.5 =10100
rent no of dwelling units = 9090
rtage = 10100 – 9090 = 1010
hortage = 1010/10100*100% = 10% Answer

A hall is 15 m long and 12 m wide. If the sum of areas of the floor and ceiling is equal to the sum of the area of its
r walls, then the volume of the hall in cubic meter is_____.

ution: Area of floor =15 x 12 = 180
a of ceiling = 15 x 12 = 180
the height of the wall be 'H' meter
cording to question,
a of Floor + Area of ceiling = Area of four walls
180 + 180 = wall perimeter x height of wall
360 = [2(15+12)] x H
360 = 54H
H = 20/3 meter
erefore, volume of room = Length x Breadth x Height = 15 x12 x20/3 = 1200 cubic meter

The actual roof area of a building is 3,60,000 sqm, which on a site plan measures 25 sq cm. The scale of the site plan
l:____.

lution: Let the scale of the plan be 1:X
, $(1/X)^2$ = (25 sq cm/ 360000 sqm)
= 25/360000 x10000 sq cm.....(1 sqm = 100cm x 100 cm = 10000 sq cm)
= $(1/12000x12000) = (1/12000)^2$
, 1/X = 1/12000

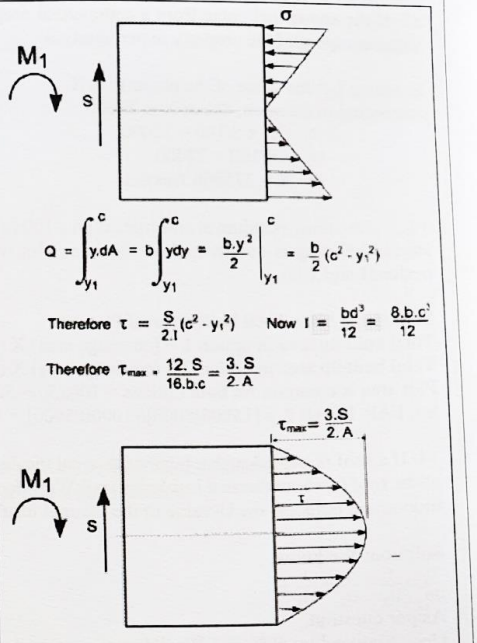


Figure: Derivation of Shear Force.

f which 6x9=54 are visible.

vailable simultaneously outdoor

l Component

re to the light level outside the

is loaded with a shear force of

GATE 2014 Q&A

y = 5x²+ 3, then the tangent at x = 0, y = 3
es through x = 0, y = 0 (B) has a slope of +1
rallel to the x-axis (D) has a slope of −1

ı: y = 5x²+ 3
(slope)
= 0, y'= 0
ation of tangent be y = mx+c (m = slope y' & c = y intercept)
, y = 3, c=3
equation of tangent y=(0)x + 3
hich is parallel to x-axis.

A foundry has a fixed daily cost of Rs 50,000 whenever it operates and a variable cost of Rs 800Q, where Q is the roduction in tonnes. What is the cost of production in Rs per tonne for a daily production of 100 tonnes?

ɪn: Total cost = 50000 + 800 x 100 = 130000 for 100 tonnes
cost of production in Rs. per tone is (130000/100) = 1300

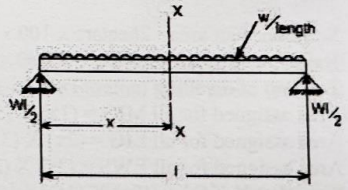
he smallest angle of a triangle is equal to two thirds of the smallest angle of a quadrilateral. The ratio between the of the quadrilateral is 3:4:5:6. The largest angle of the triangle is twice its smallest angle. What is the sum, in s, of the second largest angle of the triangle and the largest angle of the quadrilateral?

on: Sum of angles of the quadrilateral = 3x + 4x + 5x + 6x = 360
= 20
he smallest angle of a triangle is = 2/3(3x) = 2/3(60) = 40
The largest angle of the triangle is twice its smallest angle.
ıgles of the triangle are 40, 80, 60 (in degrees)
angles of the quadrilateral are 60, 80, 100, 120 (in degrees)
e sum, in degrees, of the second largest angle of the triangle and the largest angle of the quadrilateral = 120+60 =

One percent of the people of country X are taller than 6 ft. Two percent of the people of country Y are taller than here are thrice as many people in country X as in country Y. Taking both countries together, what is the percentage ople taller than 6 ft?
.0 (B) 2.5 (C) 1.5 (D) 1.25

ion: Let population in county X is 300 & 100 in Y.
people out of 300 in country X is taller than 6ft & 2 out of 100 people in country Y.
verall 5 people in 400 are taller than 6ft.
% = (5/400)x100 = 1.25

The maximum bending moment (kNm) in a simply supported beam of 8 m span subjected to a uniformly ibuted load of 20 kN/m (inclusive of its self-weight) over the entire span is
40 (B) 160 (C) 240 (D) 380

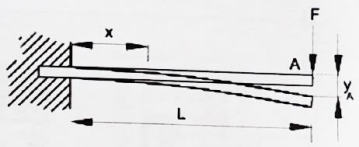


ıtion: Maximum bending moment = [WL²]/8 = [20 kN*(8m)²]/8 = 160 kNm

Criteria for background noise (in NC) in hospitals and apartments is
10 - 20 (B) 20 - 30 (C) 30 - 40 (D) 40 – 50

ıtion: Noise criteria (NC) curves can be used to evaluate existing situations by measuring sound levels at the loudest ıtions in rooms (preferably at user ear height).
y can also be used to specify the steady, or continuous background noise levels needed to help achieve satisfactory nd isolation, provided levels are 4 to 5 dB below the NC curve at both the low and high frequencies.

ment of inertia for rectangular section $I = bh^3/12$ = (0.3m)x(0.6m)^3/12
4x10^{-4}m^4
$FL^3/3EI$
⇨ Y_A = (30kN)x(5m)^3/3x(30GPa)x(54x10^{-4}m^4)
⇨ Y_A =7.71mm
Official GATE answer range is 7.65 to 7.75



0 The capacity of a hall is 600 persons and its volume is 3000 cu.m. If an optimum reverberation time of 1.0 second o be achieved then the required total absorption (m^{2}sabine) is _____.

ution: Sabine's formula, T = 0.16 V / A Where, T is the reverberation time, V is the volume of the room and A is surface area of absorbing material.
⇨ 1.0 = 0.16x3000/A
⇨ A= 480

21 A solid straight steel rod of diameter 100 mm is bent in single curvature into a circular arc by a moment of 50 m applied at its ends. If elastic modulus, E, for steel is 2 x 10^5 MPa, the radius of curvature (mm) of the arc assuming = 3.14 is _____.

lution: M = EI/R
here, M = Moment = 5000 Nm
= Elastic Modulus = 200000000000 Pa
Moment of Inertia = (pi*d^4)/64 = (3.14*0.1^4)/64 = 0.00000490625 m^4
= EI/M = 19.625m = 19625 mm
ficial GATE answer range is 19615 to 19635

GATE 2013 Q&A

1 If threshold of hearing has a sound level of zero decibels and the sound level in a broadcasting studio is 100 times the threshold of hearing, its value in decibels would be
) 0 (B) 10 (C) 20 (D) 100

olution: dB = 10log(100I/I) =10log100 = 10*2 = 20 Answer
numb rule: log10 = 1, log 100 = 2, log1000 = 3 (All base 10)

2 The width to height ratio of the front facade of Parthenon (without the pediment) is
) 9:4 (B) 4:9 (C) 1:1.618 (D) 1.618:1
olution:
he required ratio is = $\frac{Width\ of\ Front\ Facade\ of\ the\ Parthenon}{Height\ of\ the\ Parthenon\ without\ Pediment}$

$\frac{AB}{CD} = \frac{1.618}{0.618} = 2.6$
Which is approximately equal to $\frac{9}{4} = 2.2$
Nearest to the given option A)
Please note that in figure, GABE is a rectangle of golden ratio and GADH is a square. Similarly, HDBE is a rectangle of golden ratio and DBFC is a square

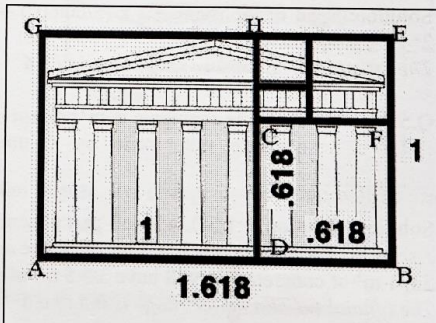


Figure: The Parthenon & the golden ratio

Total construction cost = Rs. 4000/m^2*100000*1.5 = Rs. 60 Crore
Total cost = Rs73 Crore
Cost per square meter = Rs. 73 Crore / 150000 m^2 = Rs. 4870 per square meter
So, cost of dwelling unit of 85 m^2 = Rs. 4870 * 85 m^2 = Rs. 413950
Answer

6. Determine the allowable tensile force P that may be applied across two plates connected to one another by fillet weld joints as shown in Figure. Allowable working stress of weld is 75 MPa. Consider only shearing stress in the weld. The load is applied mid way between the two welds.

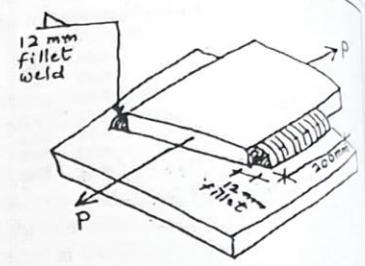


Figure: Find the force P

Solution: First calculate the area of fillet weld which is in contact with other plate. Area = 2*(12mm x 200mm)
= 4800 mm^2 = 0.0048 m^2
Force = Pressure x Area = 75MPa x 0.0048 m^2
= $75x10^6$ N/m^2 x 0.0048 m^2 = 374400 N = 274.4 kN Answer
(1 MPa = 10^6 N/m^2)

7. 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.

8. Sketch a wall footing for a 250 mm wall of a two-storied residential building on a ground having a safe bearing capacity of 10 tons/m2 at a depth of 1 m below the surface. The load from the wall at the ground level is 7 tons/m length of the wall.

Solution: Given, Load from the wall = 7 tons/meter length of wall. Width of the wall is 0.25m
So, required load = (7 tons/m) / 0.25m = 28 $tons/m^2$
Bearing capacity of the ground = 10 tons / m^2
Assume length of the wall foundation = 1 meter
Width of the wall foundation = 28 / 10 = 2.8 meters.

9. Design illumination for a 6m x 4m computer lab so as to achieve good working environment. Ceiling height is 3m and the false ceiling is at 2.4m. Draw an inverted ceiling plan and a section of the room.

Solution: As per norms, classroom or lab should have illumination level of 400 to 600 lux. Let us consider here, 500 lux is required.
So, total lumen required = 500 lux * Area = 500 $lumen/m^2$ * 24m^2 = 12000 lumen
A LED bulb available in the market is of 1000 lumen

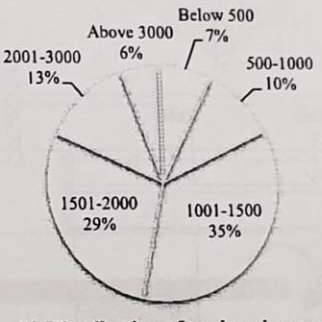
GATE 1992 Q&A

Q1. Following Information about Income pattern is available from household survey of a community.

Category	Monthly family income in rupees	Number of families
1	Below 500	45
2	501 – 1000	62
3	1001- 1500	213
4	1501 – 2000	171
5	2001 – 3000	76
6	Above 3000	33

(i) Find out percentage of families earning a monthly income above Rs. 1500
(ii) Draw a pi-diagram showing percentage distribution of various Income groups.

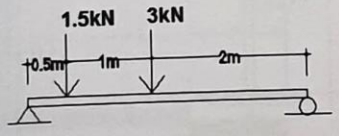
Solution: Total no. of families =
45+62+213+171+76+33 = 600
No. of families earning a monthly income above Rs. 1500 = 280
So, % = 280/600*100 = 47%



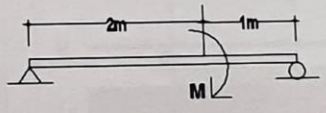
% Distribution of various income groups

Q2. Draw the bending moment and shear force diagrams for the following:

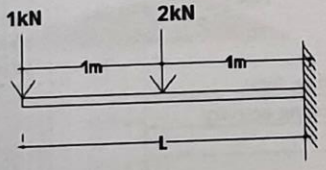
(i)



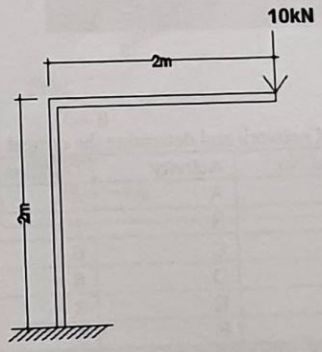
(ii)

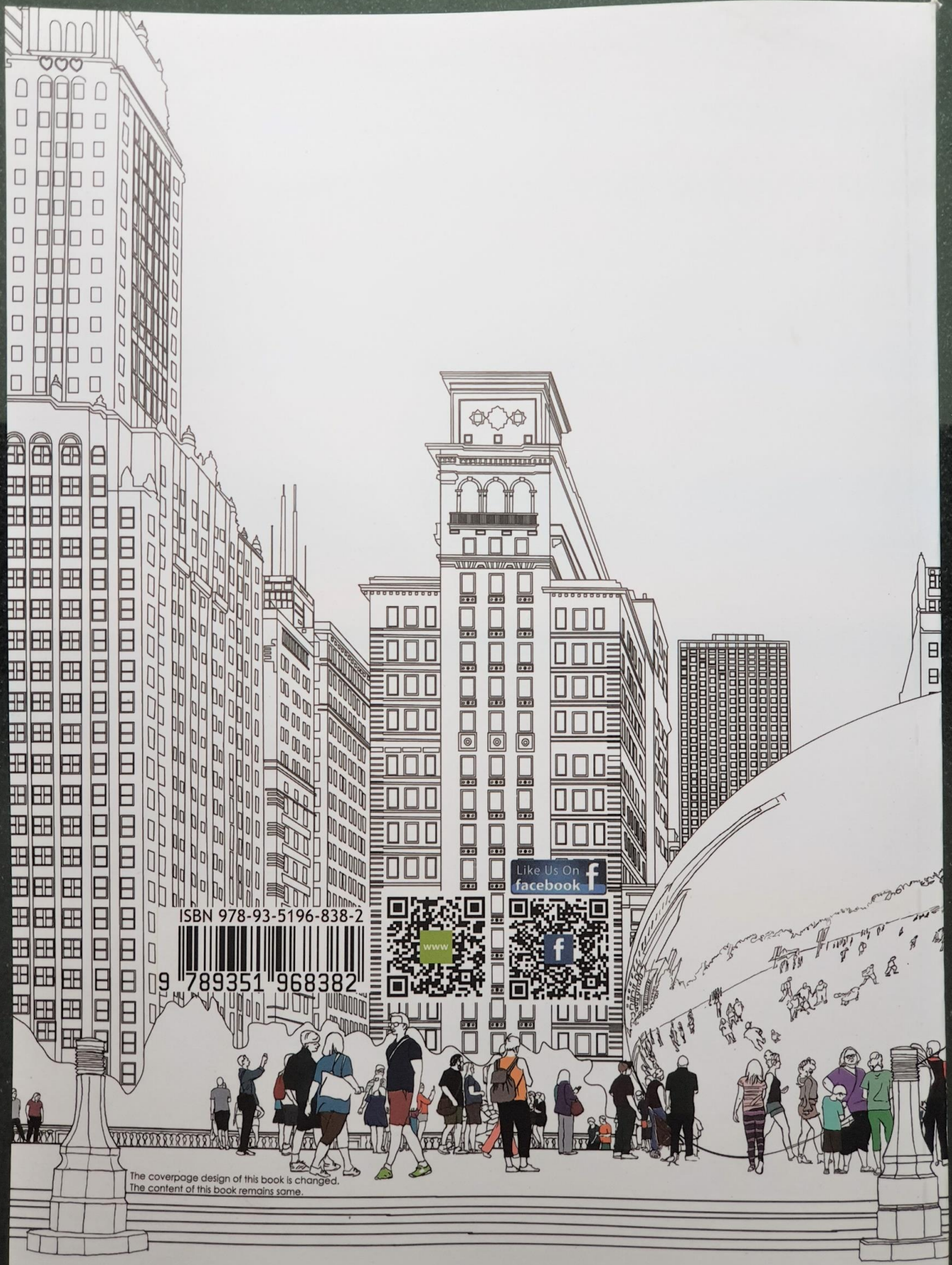


(iii)



(iv)





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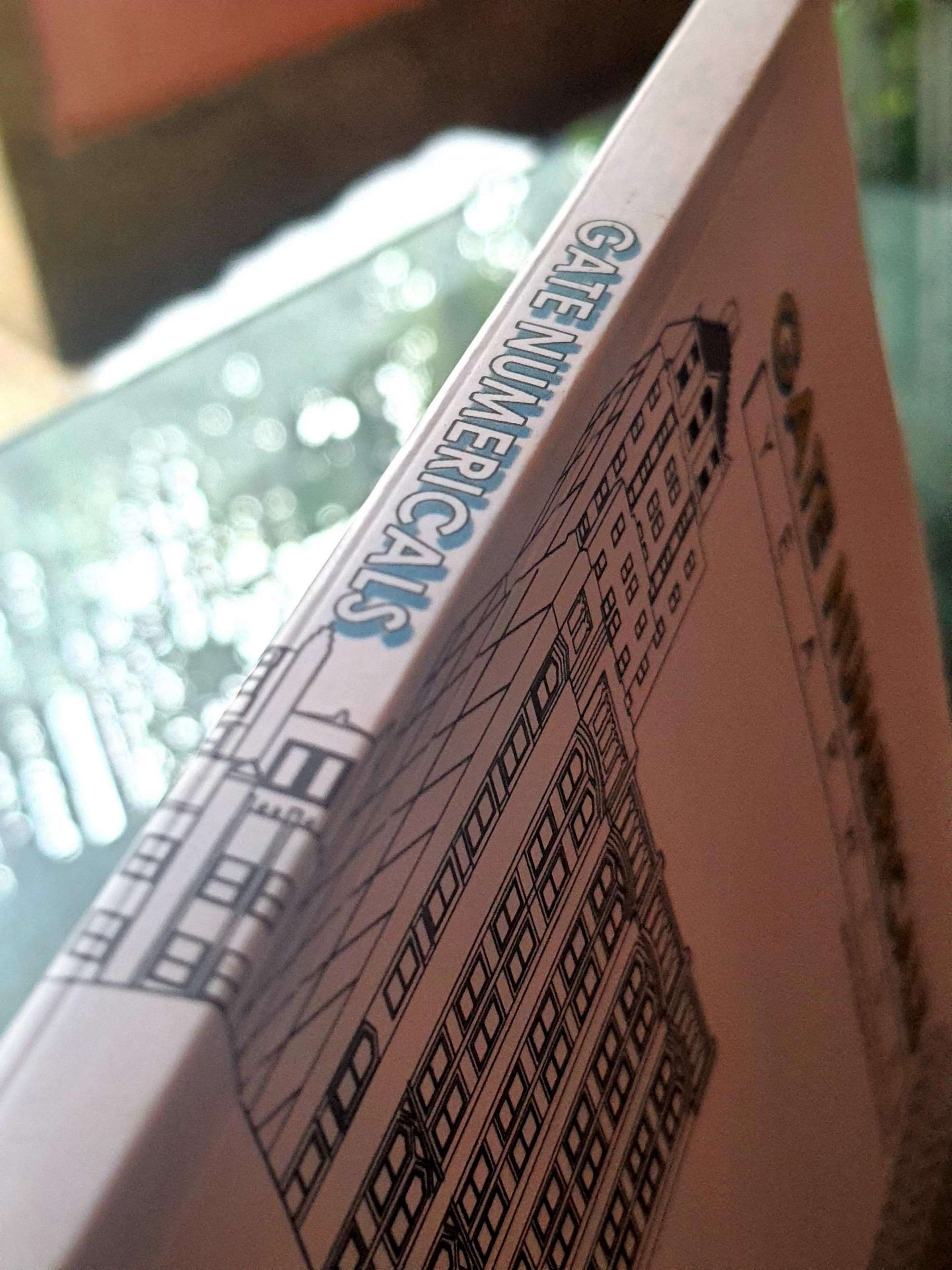
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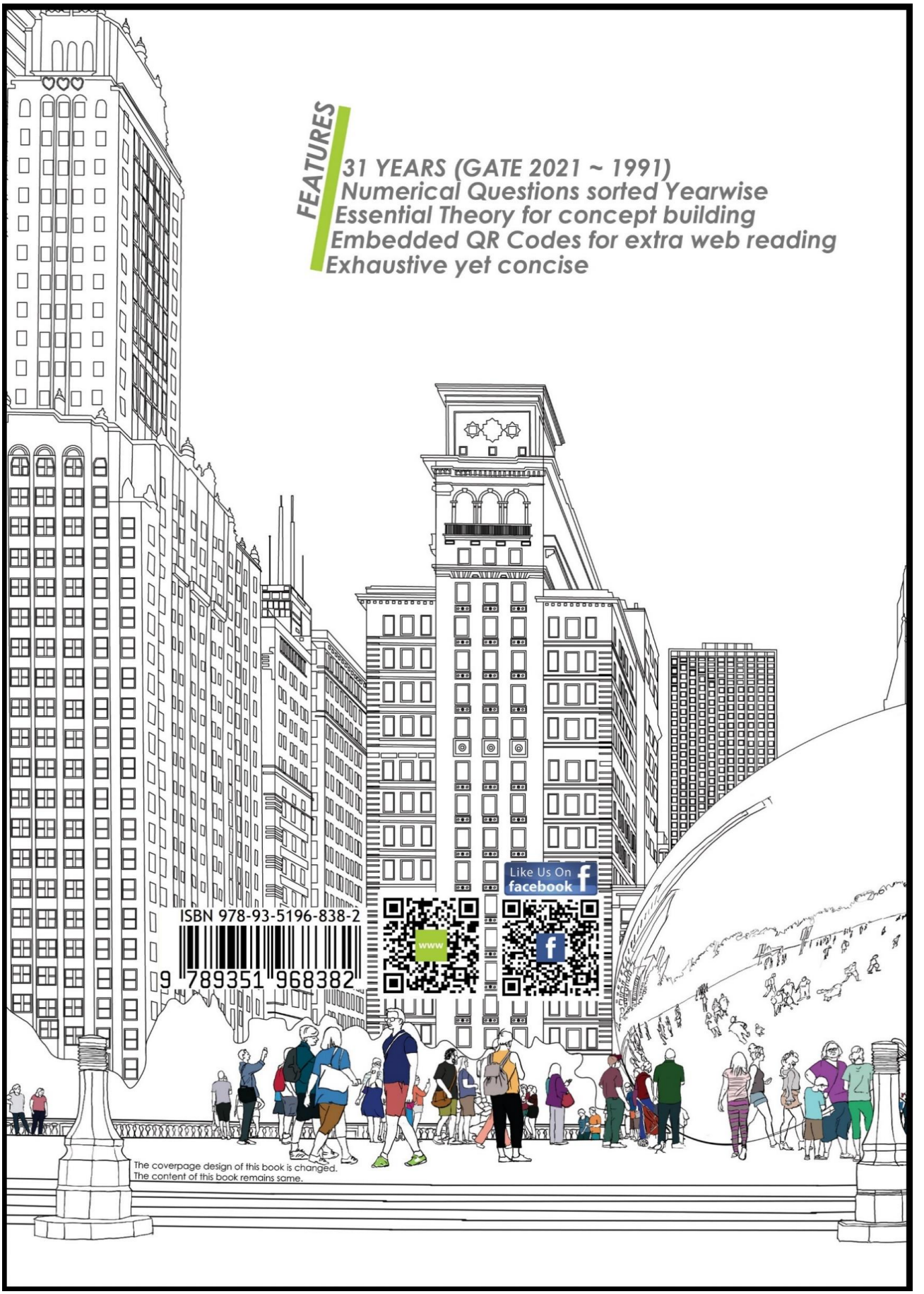

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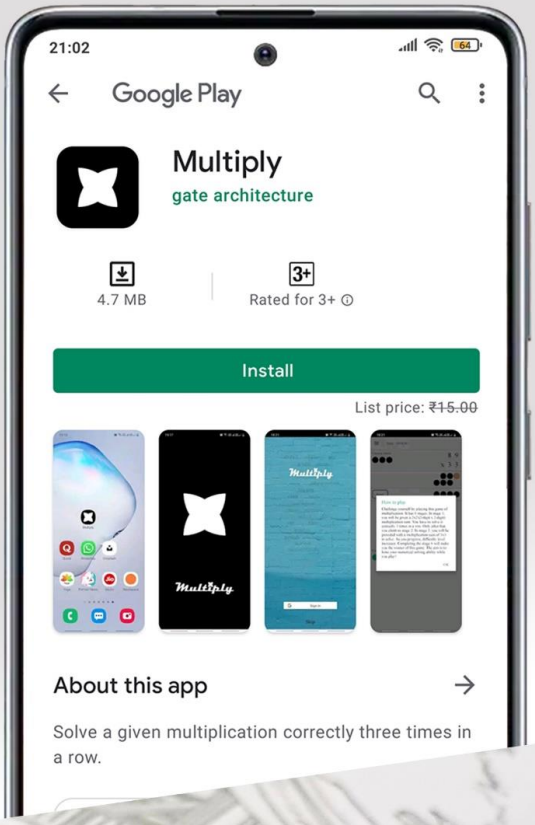

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Thank you for your time.