

# GATE NUMERICALS

3rd edition

28  
YEARS  
2018-1991

By  
Faculty of Architecture

450+  
solved  
questions  
200+ pages A4  
B & W

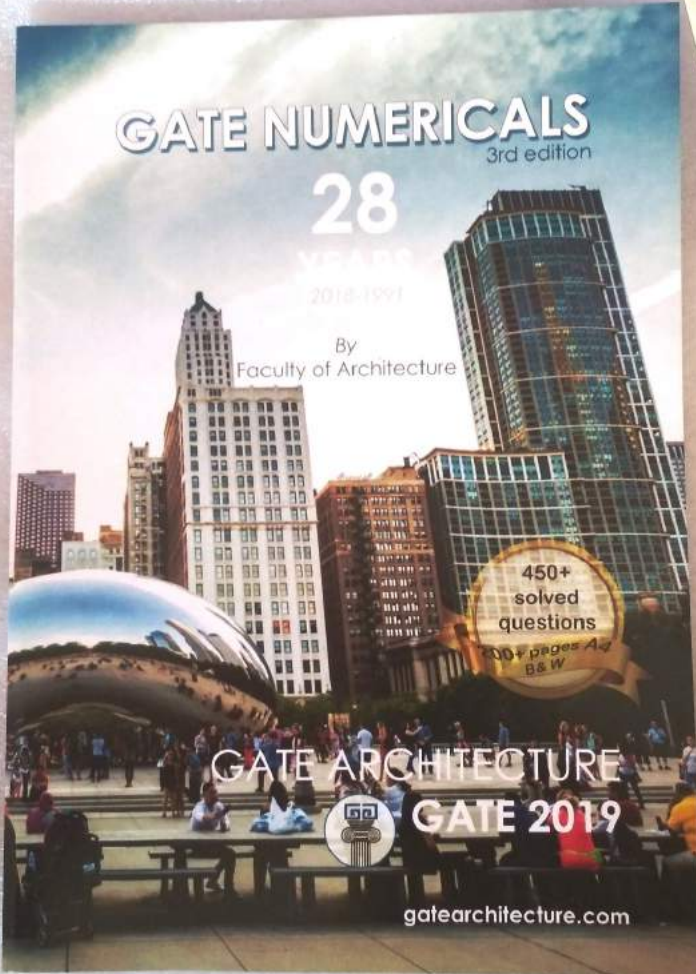
GATE ARCHITECTURE  
GATE 2019



[gatearchitecture.com](http://gatearchitecture.com)

## PLEASE NOTE:

1. This is a preview. Only few pages are displayed. Total number of pages in this book (hard copy) is 202 pages.
2. This book is also part of 'COMPLETE SET' & 'QUESTION BANK'. So, when you buy 'COMPLETE SET' or 'QUESTION BANK', you do not need to buy 'GATE NUMERICALS'
3. Contents of Topics, discussions, numericals etc. can be further included or excluded without prior information.
4. This the new edition for GATE 2019. All the shortcomings in the previous editions has been taken cared of.

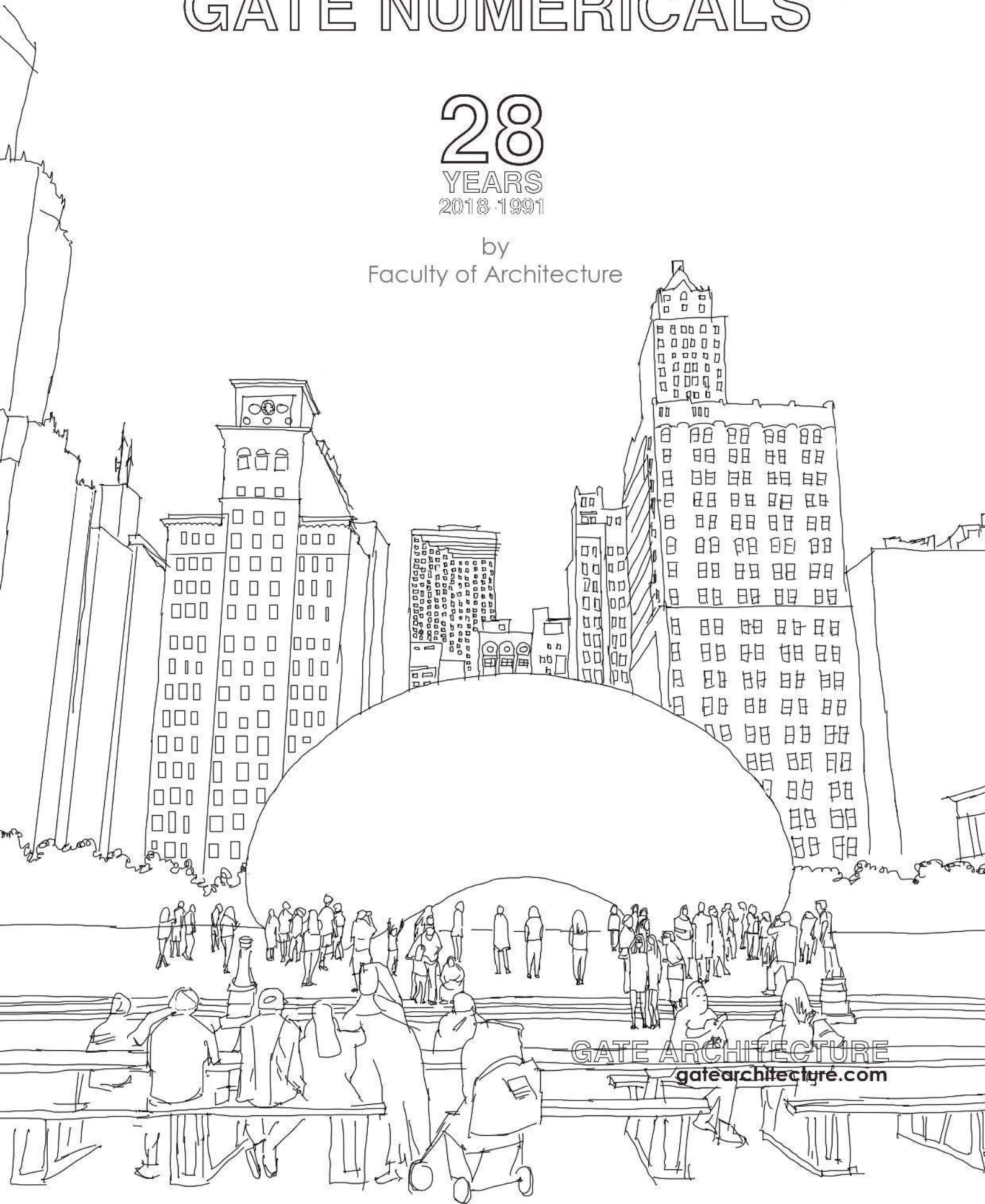


ORIGINAL PHOTOGRAPH

# GATE NUMERICALS

28  
YEARS  
2018 · 1991

by  
Faculty of Architecture



GATE ARCHITECTURE  
[gatearchitecture.com](http://gatearchitecture.com)

**Contents:**

Serial no.	Items	Total Questions	Unsolved	Page no.	Remarks by aspirant
01	Preface	xx	xx	04	
02	Tips & Tricks	xx	xx	05	
03	GATE Syllabus	xx	xx	11	
04	Acoustics notes	31	3	12	
05	Illumination notes	04	0	24	
06	Structure notes	02	0	28	
07	CPM/PERT notes	10	0	36	
08	Heat transfer notes	03	0	47	
09	GATE 2018	28	0	53	
10	GATE 2017	28	0	61	
11	GATE 2016	23	0	71	
12	GATE 2015	21	0	78	
13	GATE 2014	21	0	84	
14	GATE 2013	21	0	90	
15	GATE 2012	23	0	95	
16	GATE 2011	20	1	100	
17	GATE 2010	18	3	106	
18	GATE 2009	19	0	114	
19	GATE 2008	20	0	117	
20	GATE 2007	32	2	125	
21	GATE 2006	26	0	133	
22	GATE 2005	13	1	144	
23	GATE 2004	13	3	148	
24	GATE 2003	14	0	153	
25	GATE 2002	10	0	158	
26	GATE 2001	19	0	161	
27	GATE 2000	04	0	167	
28	GATE 1999	08	2	168	
30	GATE 1998	08	3	173	
31	GATE 1997	07	3	175	
32	GATE 1996	18	2	176	
33	GATE 1995	13	3	183	
34	GATE 1994	13	3	187	
35	GATE 1993	06	0	191	
36	GATE 1992	03	0	193	
37	GATE 1991	06	0	195	
38	References	xx	xx	198	
Total					
		505	29	Efficiency = 95%	

**Notes:** More references can be added or existing contents can be removed without prior information!

## Preface

If you have already prepared for the exam, this book would be fruitful to you. This book is meant for last stage of preparation and 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. It is observed that upto 40% marks are of numerical questions. There would be approx. 7 numerical question of 1 or 2 marks of which no option would be 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!)

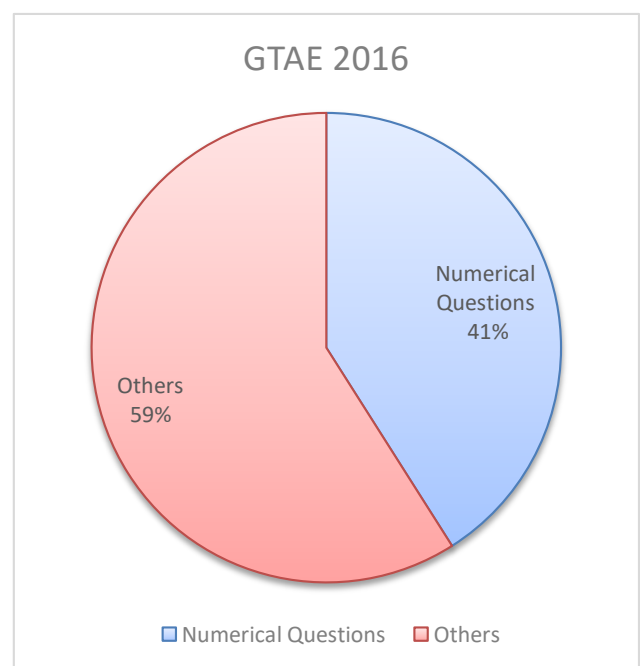
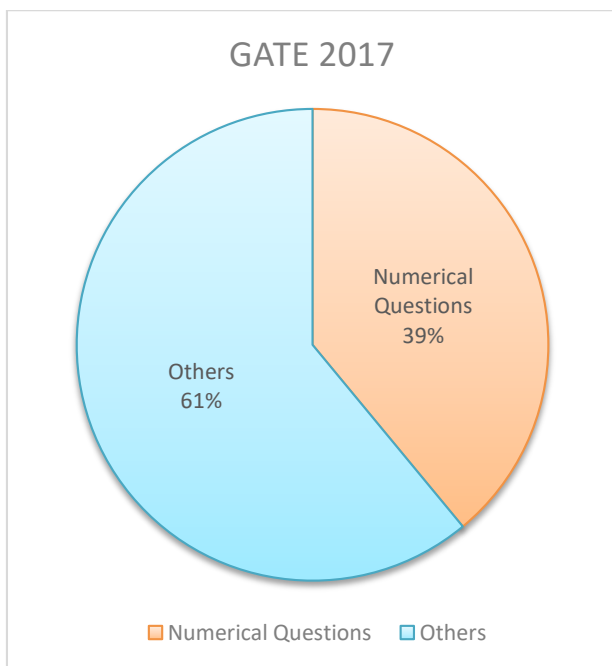
So, for such question pattern, you need through practice. We are hopeful that this book would meet the requirement.

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.

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

Last year trend (GATE 2016 AR):

No. of students applied (Approx.)	No. of students appeared (Approx.)	No. of students qualified	Highest marks obtained	Lowest mark obtained	Cut-off Mark	Average marks obtained	Standard deviation
6300	5900	1240	75.67	26.00	38.90	43.37	8.32



Most of the questions has been solved (95%). 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](mailto:gatearchitecture@gmail.com)  
We may add contents or solution by you in next reprint or edition!

We wish you all the best for GATE 2018.

## Tips & Tricks

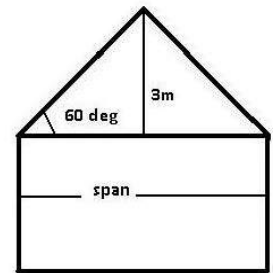
Followings are tips & tricks for handling multiple choice questions suggested by experts from open source online resources. Please note that following insights are not only for Numerical Questions but also for all topics. Some of following are for paper bound exam (not online). You should skip those.

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  $60^\circ$  and height of the roof is 3 m, span of the room, in m, would be \_\_\_\_\_

Solution: Span of the room =  $2 * (3/\tan 60^\circ) = 3.46$  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 ( $l = 0.5\text{m}$ ). 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 =  $\pi r^2 = 3.14 \times 4\text{mm} \times 4\text{mm} = 50.24 \text{ sq mm}$  { 8mm rod means it has diameter of 8mm

So, total no. of rods spread in 1m of width =  $\frac{335\text{sqmm}}{50.24\text{sqmm}} = 335 / 50.24 = 6.67$  { 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  $1\text{m}/6.67 = 1000 \text{ mm}/6.67 = 150 \text{ mm}$  Answer { Here, please note that we are dividing  $1000\text{mm}/6.67$  and not  $1\text{m}/6.67$ . 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.

## Important Topics

### 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 audience is termed as architectural acoustics or acoustics of the building.

### Intensity 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<sup>2</sup>, hearing threshold)

I: intensity (W/cm<sup>2</sup>)

For the intensity level change = 1 dB

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

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

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

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

Sr. No.	Sound	Intensity level (in db)
(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 given frequency is sounded. It enables us to classify a note as high or low and to distinguish a shrill sound from a flat 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.

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

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

**Solution:** Given,

Initial intensity =  $I_0$

Final intensity =  $I$

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

Increase in intensity level =  $L$

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

$$\therefore L = 10 \log_{10} 100 = 20 \text{ dB Answer.}$$

**Example: Find the intensity level in phons if 3000 Hz with intensity level of 70 dB produces the same loudness as 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 level of the note of frequency 3000 Hz is 67 phons. **Answer.**

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

**Solution:** Step 1. **Convert dB (intensity level) to intensity ( $W/cm^2$ )**

$$IL_1 = 10 \log (I_1/I_0)$$

$$60 = 10 \log (I_1/10^{-16})$$

$$6.0 = \log (I_1/10^{-16})$$

$$10^6 = I_1/10^{-16}$$

$$I_1 = 10^{-10}$$

$$IL_2 = 10 \log (I_2/I_0)$$

$$50 = 10 \log (I_2/10^{-16})$$

$$5.0 = \log (I_2/10^{-16})$$

$$10^5 = I_2/10^{-16}$$

$$I_2 = 10^{-11}$$



**Step 2. Add intensity together**

$$I_1 + I_2 = 1 \times 10^{-10} + 1 \times 10^{-11}$$

$$I_{TOT} = 11 \times 10^{-11} \text{ W/cm}^2$$

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

$$IL_{TOT} = 10 \text{ Log } (I_{TOT}/I_0)$$

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

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

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

The above calculation is time consuming & requires a lot of calculations. For approximate answer, follow the below thumb rule:

**Question: Add two 60 dB sources**

**Solution:**  $\Delta\text{dB}=0$  {difference in two dB sources is zero}

Now, add 3 db to higher

$$IL = 60 + 3 = 63 \text{ dB}$$

**The Inverse Square Law**

The inverse square law is one of the fundamental

concepts used in the business of sound and acoustics. Fundamentally, this is what the inverse square law describes:

- Every time the physical distance between you and the sound source doubles in distance, the sound will be 6 dB lower (softer).
- The opposite holds true too. As the distance is cut in half, the sound will get louder by 6 dB
- There are exceptions, but they are not critical to this discussion.

Here is a very basic example: Start with a sound source that is 86 dB when measured 3' in front of the source. Measure again at a distance of 6' and you will get a measurement of 80 dB, which is 6 dB lower. Move from 6' to 12' and the measurement will be 74 dB. Move from 12' to 24' and you get 68 dB. See the pattern? All this reverses when you move toward the source of the sound.

**Critical Distance:** In the glossary of audio terminology, "critical distance" defines the point at which direct sound and reverberant sound have the same SPL (Sound Pressure Level).

**Reverberation and Echo**

Reverberation and echo are often perceived as two separate acoustical phenomena, but in reality they are very much the same thing; just perceived differently because of the size and geometric characteristics of a room.

**Reverberation** (reverb) is highly-diffused sound energy that has reflected off of several surfaces or structural boundaries.

**Echo** is non-diffused, reflected sound energy, which exceeds our ear/brain "integration time".

For spoken word, the human ear/brain system perceives direct sound, and reflected sound that arrives within a range of about 30-60 milliseconds (ms), as being one in the same signal. The two discrete time arrivals are integrated or merged into one. The time arrival of the two is so close that we can't tell them apart.

A. 60ms represents the upper limits of this integration time, after which the late arriving sound is perceived as a discrete echo.

B. Based on many factors, the integration time for music can be slightly longer than 60 ms, but speech integration, and therefore intelligibility, are almost always the dominant concern.

1. A repetitive echo is sometimes called "flutter" echo because percussive sounds, like a hand clap, bounce rapidly between one or more sets of parallel surfaces, producing a "fluttery" sound.

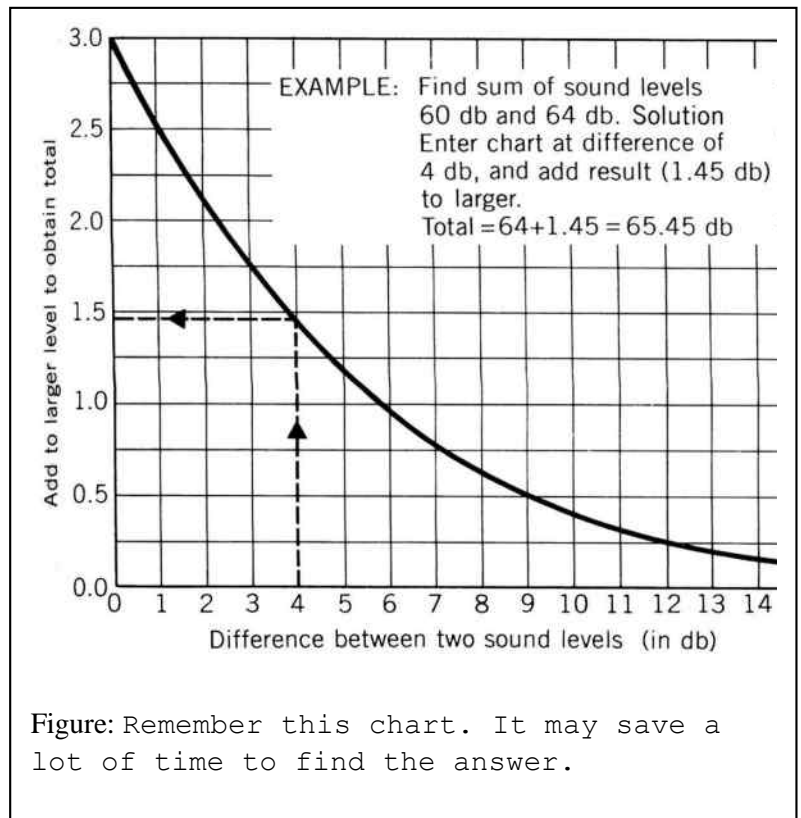


Figure: Remember this chart. It may save a lot of time to find the answer.

## 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 and 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 most 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.

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<sup>2</sup>. A full sphere measures  $4\pi$  steradians.

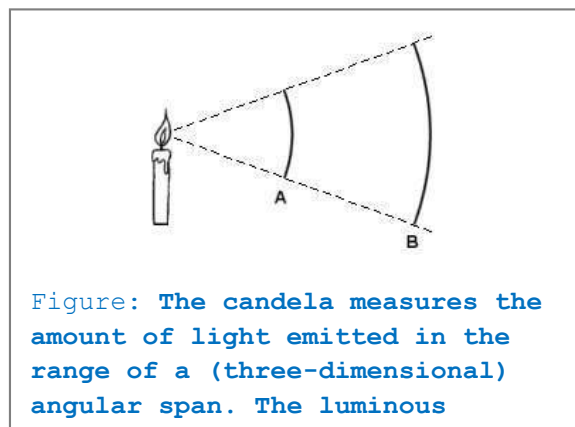
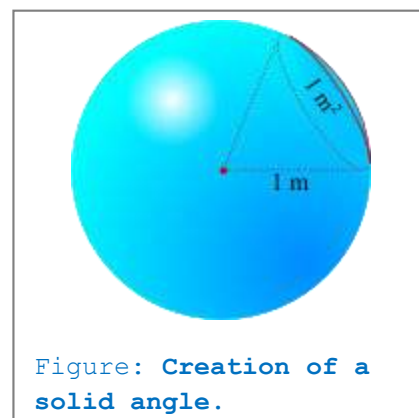
#### Lumen

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.

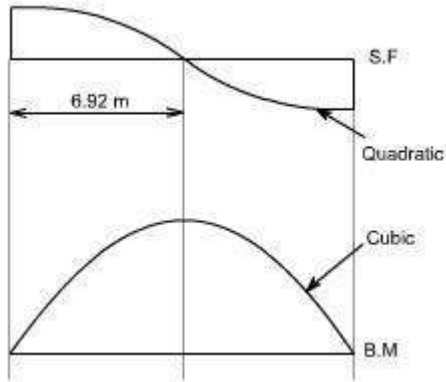
The cause for this relation is the total energy produced by the LED. LEDs of a specific class (for example, "high flux") all produce roughly the same amount of luminous energy. However, when a LED emits its total energy in a beam with a narrow angle, the intensity will be greater (in the direction of 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  $\Phi_v$  for lumen,  $I_v$  for candela and  $\Omega$  for the angular span in steradian, the relation is:

$$\Phi_v = I_v \cdot \Omega$$

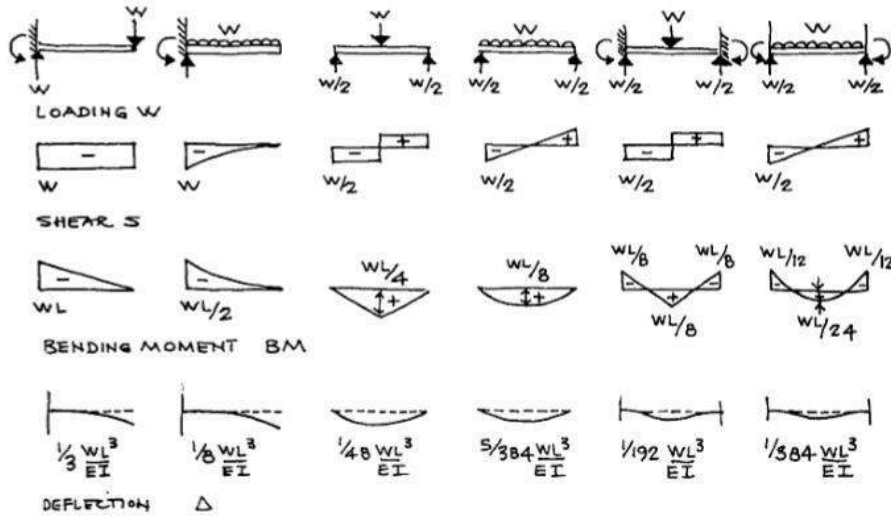


Common Relationships



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

## CPM/PERT

### Introduction

Basically, CPM (Critical Path Method) and PERT (Programme Evaluation Review Technique) are project management techniques, which have been created out of the need of Western industrial and military establishments to plan, schedule and control complex projects.

### Brief History of CPM/PERT

CPM/PERT or Network Analysis as the technique is sometimes called, developed along two parallel streams, one industrial and the other military.

CPM was the discovery of M.R.Walker of E.I.Du Pont de Nemours & Co. and J.E.Kelly of Remington Rand, circa 1957. The computation was designed for the UNIVAC-I computer. The first test was made in 1958, when CPM was applied to the construction of a new chemical plant. In March 1959, the method was applied to a maintenance shut-down at the Du Pont works in Louisville, Kentucky. Unproductive time was reduced from 125 to 93 hours.

PERT was devised in 1958 for the POLARIS missile program by the Program Evaluation Branch of the Special Projects office of the U.S.Navy, helped by the Lockheed Missile Systems division and the Consultant firm of Booz-Allen & Hamilton. The calculations were so arranged so that they could be carried out on the IBM Naval Ordnance Research Computer (NORC) at Dahlgren, Virginia.

### The Framework for PERT and CPM

Essentially, there are six steps which are common to both the techniques. The procedure is listed below:

1. Define the Project and all of its significant activities or tasks. The Project (made up of several tasks) should have only a single start activity and a single finish activity.
2. Develop the relationships among the activities. Decide which activities must precede and which must follow others.
3. Draw the "Network" connecting all the activities. Each Activity should have unique event numbers. Dummy arrows are used where required to avoid giving the same numbering to two activities.
4. Assign time and/or cost estimates to each activity
5. Compute the longest time path through the network. This is called the critical path.
6. Use the Network to help plan, schedule, monitor and control the project.

The Key Concept used by CPM/PERT is that a small set of activities, which make up the longest path through the activity network control the entire project. If these "critical" activities could be identified and assigned to responsible persons, management resources could be optimally used by concentrating on the few activities which determine the fate of the entire project.

Non-critical activities can be replanned, rescheduled and resources for them can be reallocated flexibly, without affecting the whole project.

Five useful questions to ask when preparing an activity network are:

- Is this a Start Activity?
- Is this a Finish Activity?
- What Activity Precedes this?
- What Activity Follows this?
- What Activity is Concurrent with this?

Some activities are serially linked. The second activity can begin only after the first activity is completed. In certain cases, the activities are concurrent, because they are independent of each other and can start simultaneously. This is especially the case in organisations which have supervisory resources so that work can be delegated to various departments which will be responsible for the activities and their completion as planned.

When work is delegated like this, the need for constant feedback and co-ordination becomes an important senior management pre-occupation.

## Heat

Understanding fundamental heat flows from conduction, convection, and radiation is key to creating energy efficient buildings. Moisture flows are also important because moisture holds energy as “latent heat.”

### Sensible vs. Latent Heat Flows

There are two forms of heat flows: **sensible heat** and **latent heat**. Sensible heat flow results in a change in temperature. Latent heat flow results in a change in moisture content (often humidity of the air). Total heat flow is the sum of sensible and latent flows. Human comfort depends on providing acceptable levels of both temperature (sensible heat) and humidity (latent heat).

**Sensible heat:** The heat associated with change in temperature of a substance/

**Latent heat:** The release or storage of heat associated with change in phase of a substance, without a change in the substance’s temperature. In building design, this is often heat required to add/remove moisture content (humidity) in the air. Hot dry air is actually less uncomfortable than hot humid air, because moisture holds energy as latent heat.

Whenever an object is at a temperature different from its surroundings, heat flows from hot to cold. Likewise, moisture flows from areas of greater concentration to areas of lower concentration.

### Conduction, Convection, and Radiation

Buildings lose sensible heat to the environment (or gain sensible heat from it) in three principal ways:

- 1) **Conduction:** The transfer of heat between substances which are in direct contact with each other. Conduction occurs when heat flows through a solid.
- 2) **Convection:** The movement of gasses and liquids caused by heat transfer. As a gas or liquid is heated, it warms, expands and rises because it is less dense resulting in natural convection.
- 3) **Radiation:** When electromagnetic waves travel through space, it is called radiation. When these waves (from the sun, for example) hit an object, they transfer their heat to that object.

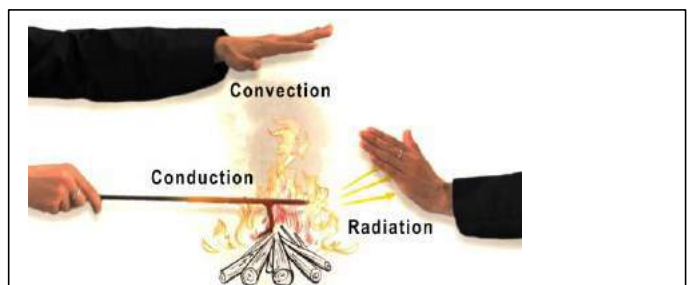


Figure: The way that you experience the heat from a fire is a good example of conduction, convection, and radiation. Heat conducts through materials placed in the fire, like a metal poker. You can stop the conduction to your hand by using an insulating pad. Heat (and smoke) travels away from the fire through the air. The direction it travels depends on the wind and pressure differences (convection). Heat radiates from the fire to where you are. You can avoid the radiation by putting a material between you and the fire, or stepping away.

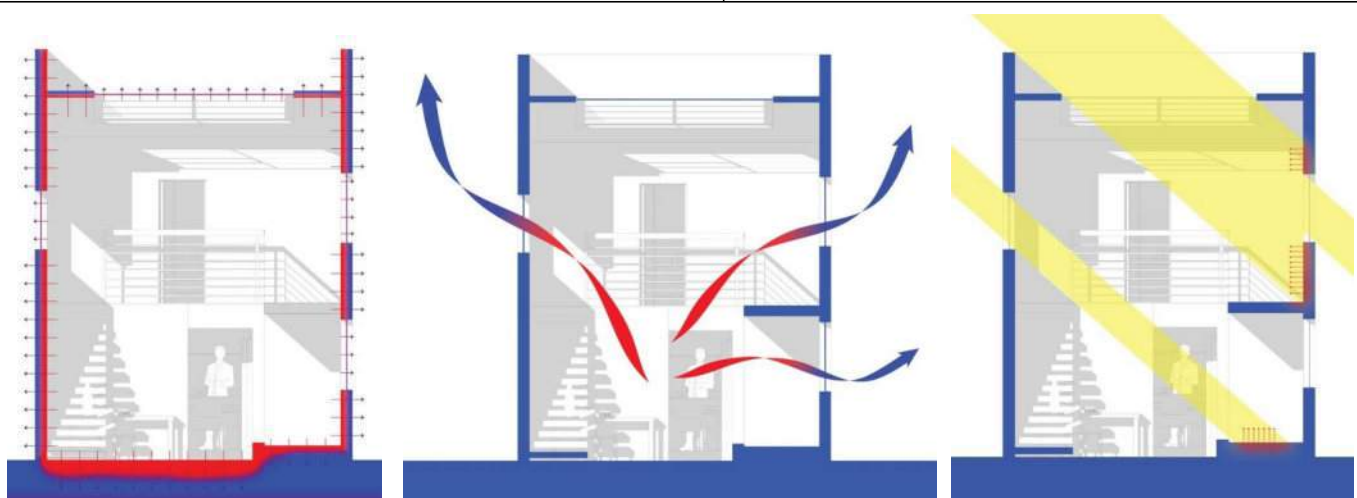


Figure: Conduction, convection, and radiation heat transfer take place almost everywhere we look. In a building envelope, conduction primarily takes place through opaque envelope assemblies, convection is usually the result of wind or pressure-driven air movement, and radiant heat transfer is primarily from the sun through fenestrations. Building HVAC systems are typically designed to provide comfort using convective or radiant modes of heat transfer.

## GATE QUESTION PAPERS

## GATE 2018

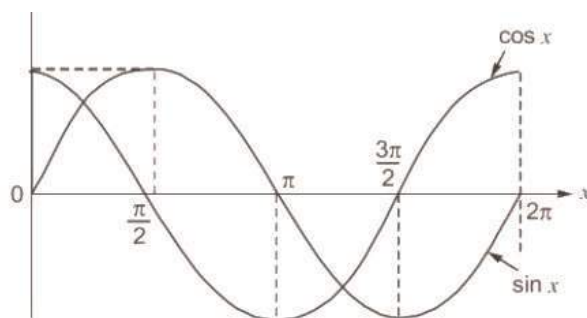
**Q.1** For  $0 \leq x \leq 2\pi$ ,  $\sin x$  and  $\cos x$  are both decreasing functions in the interval.

- (A)  $(0, \pi/2)$       (B)  $(\pi/2, \pi)$       (C)  $(\pi, 3\pi/2)$       (D)  $(3\pi/2, 2\pi)$

Answer: B

From the curve it is clear that  $\sin x$  and  $\cos x$  both are decreasing in the interval  $(\pi/2, \pi)$

How to plot the graph? To plot this graph you need to know the value of  $\sin\theta$  &  $\cos\theta$  for the values of  $0^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$  and  $90^\circ$ . For that you do not have to remember the values. Open the 'Scientific Calculator' by clicking on the icon of calculator on the question screen during GATE exam.

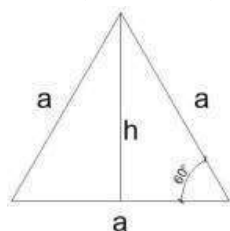


**Q.2** The area of an equilateral triangle is  $\sqrt{3}$ . What is the perimeter of the triangle?

- (A) 2      (B) 4      (C) 6      (D) 8

Answer: C

Area of triangle =  $1/2$  (Base\*Height) =  $1/2$  ( $a*h$ )  
 $= 1/2$  ( $a*a \sin 60^\circ$ ) =  $1/2$  ( $a^2\sqrt{3}/2$ ) =  $\sqrt{3}$  (given)



So, perimeter of triangle =  $3*a = 3*2 = 6$  **Answer**

**Q.3** Arrange the following three-dimensional objects in the descending order of their volumes:

- (i) A cuboid with dimensions 10 cm, 8 cm and 6 cm  
 (ii) A cube of side 8 cm  
 (iii) A cylinder with base radius 7 cm and height 7 cm  
 (iv) A sphere of radius 7 cm

- (A) (i), (ii), (iii), (iv)  
 (B) (ii), (i), (iv), (iii)  
 (C) (iii), (ii), (i), (iv)  
 (D) (iv), (iii), (ii), (i)

Answer (D)

Volume of cuboid =  $l*b*h = 10*8*6 = 480$

Volume of cube =  $l^3 = 8^3 = 512$

Volume of cylinder = (perimeter)\*(height) =  $2\pi r*h = 2\pi*7*7 = 615$

Volume of sphere =  $4/3 * \pi r^3 = 1432$

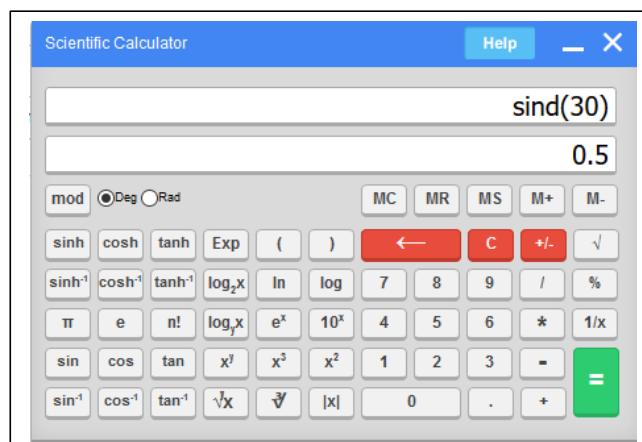


Figure: Visit the official GATE website and appear for a Mock Test to be familiar with function of the 'Scientific Calculator' and UI.

**Q.4** An automobile travels from city A to city B and returns to city A by the same route. The speed of the vehicle during the onward and return journeys were constant at 60 km/h and 90 km/h, respectively. What is the average speed in km/h for the entire journey?

(A) 72 (B) 73 (C) 74 (D) 75

Answer (A)

Solution, Let, the distance between city A & B be  $x$

So, total distance (onward & return journey) =  $x + x = 2x$

For onward journey, speed  $S_1 = 60\text{km/h}$  and time taken =  $x/60$

For return journey, speed  $S_2 = 90\text{km/h}$  and time taken =  $x/90$

Therefore, Average Speed = Total Distance/Total Time =  $(x+x)/[x/60+x/90] = 2*90*2/5 = 72 \text{ km/h}$

**Q.5** A set of 4 parallel lines intersect with another set of 5 parallel lines. How many parallelograms are formed?

(A) 20 (B) 48 (C) 60 (D) 72

Answer (C)

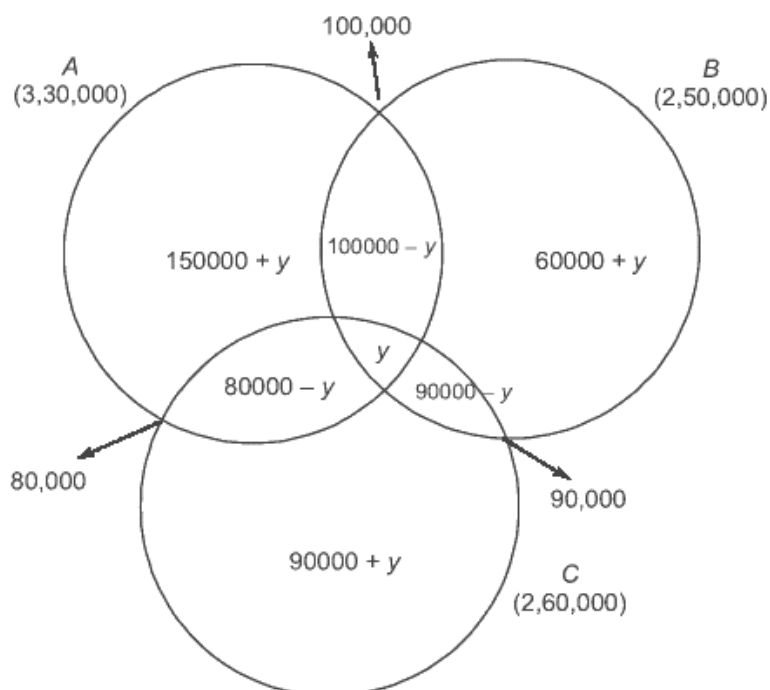
To make a parallelogram we need two parallel lines in one direction and other two parallel lines in other direction. It is given that we have 4 parallel lines in one direction and 5 parallel lines in other direction. Now, we have to choose any 2 parallel lines from 4 parallel lines and other 2 lines from the other 5 parallel lines. In mathematics, number of

parallelogram =  ${}^4C_2 \times {}^5C_2 = 6 \times 10 = 60$  Answer

**Q.6** To pass a test, a candidate needs to answer at least 2 out of 3 questions correctly. A total of 6,30,000 candidates appeared for the test. Question A was correctly answered by 3,30,000 candidates. Question B was answered correctly by 2,50,000 candidates. Question C was answered correctly by 2,60,000 candidates. Both questions A and B were answered correctly by 1,00,000 candidates. Both questions B and C were answered correctly by 90,000 candidates. Both questions A and C were answered correctly by 80,000 candidates. If the number of students answering all questions correctly is the same as the number answering none, how many candidates failed to clear the test?

(A) 30,000 (B) 2,70,000 (C) 3,90,000 (D) 4,20,000

Answer (D)



$$6,30,000 = 2y + 1,50,000 + 1,00,000 + 80,000 + 60,000 + 90,000 + 90,000$$

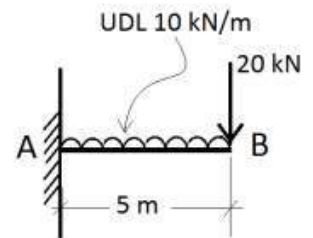
$$\Rightarrow 6,30,000 - 5,70,000 = 2y$$

$$\Rightarrow y = 30,000 \text{ Answer}$$

Student who failed to clear the test =  $1,50,000 + 60,000 + 90,000 + 4y = 3,00,000 + 4 \times 30,000 = 4,20,000$  Answer

**Q.23 In the Figure, the negative bending moment at point A of the cantilever is \_\_\_\_\_ kNm.**

Solution: The question will be very easy if divide the question in 2 parts. In part one, find the moment due to UDL of 10 kN/m and in second part, find the moment due to point load of 10kN. And then add both.



Moment =  $WL^2/2 + WL$   
 $= (10\text{kN/m} \times 5\text{m} \times 5\text{m})/2 + 20\text{kN} \times 5\text{m} = 125 + 100 = 225\text{Nm}$  Answer (Official GATE answer varied from 224 to 226)  
 Refer Question No. 3 of GATE 2002 in this book as a reference.

**Q.23 The water consumption of a high rise apartment building with 60 dwelling units having an average household size of 5 persons is 135 lpcd. Assuming 80% of the total use is met with recycled water supply, the daily domestic demand for the building is \_\_\_\_\_ litres.**

20% of  $(60 \times 5 \times 135) = 8100$  litres Answer

**Q.24 In India, for 1.0 cum of M-20 grade concrete, the number of cement bags required is \_\_\_\_\_ (up to two decimal places).**

As we know that during concreting when we place wet concrete, it gets harden after certain standard time (30 mins IST & 10hrs FST), considering same it had be decided to take a factor of safety ranging from 1.54 to 1.57 to counter that shrinkage. i.e volume of dry Concrete = 1.54 to 1.57 times volume of wet concrete.

Now calculations is as follows for 1cum of Concrete work

Ratio Sum =  $1 + 1.5 + 3 = 5.5$

Shrinkage or safety Factor = 1.57 (you can take 1.54 also)

So Total volume of wet concrete required is 1.57cum

Volume of broken stone required =  $(3/5.5) \times 1.57 = 0.856 \text{ m}^3$

Volume of sand required =  $(1.5/5.5) \times 1.57 = 0.471 \text{ m}^3$

Volume of cement =  $(1/5.5) \times 1.57 = 0.285 \text{ m}^3 = 0.285 \times 1440 = 411 \text{ kg}$

For  $1\text{m}^3$  of M20 (1:1.5:3)

Broken stone =  $0.856 \text{ m}^3$

Sand =  $0.472 \text{ m}^3$

**Cement = 8.22 bag.**

(Official GATE answer varied from 5 to 9)

[https://www.researchgate.net/post/how we calculate of Sand cement and aggregate of M20 ratio or other ratio](https://www.researchgate.net/post/how_we_calculate_of_Sand_cement_and_aggregate_of_M20_ratio_or_other_ratio)

**Q.25 The sound power level of an outdoor non-directional point source is 90 dB. Considering an atmospheric impedance of 400 rayls, the sound pressure level at 10 m distance from the source is \_\_\_\_\_ dB.**

Solution:

$$L_p = L_w - |10 \cdot \log \left( \frac{Q}{4\pi \cdot r^2} \right)|$$

Where,

$L_w$  = Sound power level (SWL) = 90dB

$Q$  = Directivity factor = 1 (for 400 rayls)

$r$  = Distance to sound source = 10 meters

$L_p$  = Sound pressure level (SPL) = **59 dB** Answer

(Official GATE answer varied from 58 to 59)

<http://www.sengpielaudio.com/calculator-soundpower.htm>



## GATE 2017

**Q.1 The unit for measuring sound absorption in a room is**

- (A) Sabin (B) Phon (C) Decibel (3) Hertz

Notes: The term “**sound absorption**” very common to acoustics and question is asked very frequently in GATE for calculating Reverberation time =  $0.016 \cdot (V/a)$ , where  $a$  = **sound absorption** coefficient in Sabin.

The unit is named in honor of Wallace Clement Sabine. So, Sabin is a unit of Sound Absorption of a surface. A square metre of 100% absorbing material has a value of 1 metric sabin. An example of this would be a 1 m<sup>2</sup> open window. One square foot of 100% absorbing material has a value of 1 imperial sabin.

**Decibels, Phons, and Sones:**

The rate at which sound energy reaches a given cross-sectional area is known as the sound intensity. It is common to express the sound intensity using a logarithmic scale known as the **decibel** scale.

Sound loudness varies from person to person. Furthermore, sounds with equal intensities but different frequencies are perceived by the same person to have unequal loudness. For instance, a 60 dB sound with a frequency of 1000 Hz sounds louder than a 60 dB sound with a frequency of 500 Hz. The unit **phon** is used to indicate an individual's perception of loudness. By definition, 1 phon is equivalent to 1 deciBel at 1000 Hz (1 kHz).

The sone scale is a third scale associated with the loudness of a sound. The sone scale is based on the observation that a 10 phon increase in a sound level is most often perceived as a doubling of loudness.

According to the sone scale, a 1 sone sound is defined as a sound whose loudness is equal to 40 phons.

**Answer: (A) Sabin**

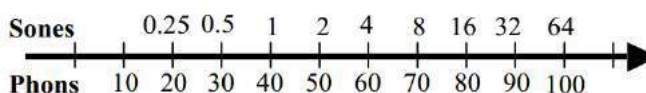


Figure: Relationship between Phon & Sone. Thumb rule.

**Q.2 A drainage basin of 180 hectares comprises 40% wooded area, 45% grassed area and 15% paved area. Runoff coefficients for wooded, grassed and paved areas are 0.01, 0.2 and 0.95 respectively. The composite runoff coefficient for the drainage basin is**

Solution:  $C = [(0.01 \times 40\% \text{ of } 180) + (0.2 \times 45\% \text{ of } 180) + (0.95 \times 15\% \text{ of } 180)] / 180 = (0.72 + 16.2 + 25.65) / 180 = 0.236 = 0.24$

Composite runoff coefficient,  $C = (A_1 \cdot C_1 + A_2 \cdot C_2 + \dots) / (A_1 + A_2 + \dots)$

**Answer: 0.24**

**Q3. He was one of my best \_\_\_\_\_ and I felt his loss \_\_\_\_\_**

- (A) friend, keenly (B) friends, keen (C) friend, keener (D) friends, keenly

Solution: In the first blank, the word ‘friends’ is apt. The author talks about him being one of the many, he has. In the second blank, the word ‘keen’, which means ‘sharp, piercing, or biting’ can be used to describe an emotional loss. The word ‘keen’ in this sentence is modifying ‘felt’, which is a verb. Hence it must be used in its adverbial form. Hence, ‘keenly’ is apt.

Hence, the correct option is (D).

**Q4. As the two speakers became increasingly agitated, the debate became**

- (A) lukewarm (B) poetic (C) forgiving (D) heated

Solution: The word ‘agitated’ shows that the two speakers became disturbed and excited- leading to a heated arguments. ‘Heated’ means to be excited or to be aroused to a high degree of passion or feeling. The rest of the options are inapt.

Hence, the correct option is (D).

**Q9. One litre of acrylic paint can cover 16 sqm of wall area for the first coat and 24 sqm for the second coat. The walls of a lecture hall measuring  $12\text{m} \times 8\text{m} \times 4\text{m}$  ( $L \times B \times H$ ) need to be painted with two coats of this paint. The hall has total glazed fenestration area of 12 sqm. The number of 4 litre paint containers required will be \_\_\_\_\_ (2 marks)**

**Solution:** Area to be painted = Area of walls – Area of window =  $160 - 12 = 148$  sqm

Paint required for 1<sup>st</sup> coat =  $148/16 = 9.25$  litres.....(A)

Paint required for 2<sup>nd</sup> coat =  $148/24 = 6.17$  litres.....(B)

Total paint =  $9.25 + 6.17 = 15.42$  litres = 16 litres

So, The number of **4-litre paint containers** required will be  $16/4 = 4$  containers

**Also, the answer provided by the official GATE is 4** but we do not agree with this answer because *Paint required for 1<sup>st</sup> coat = 9.25 litres (A)* seems incorrect as 9.25 litres of paint can do 148 sqm of first coat and *also  $9.25 \times 24 = 222$  sqm* of second coat. Similarly *Paint required for 2<sup>nd</sup> coat = 6.17 litres (B)* may be incorrect as 6.17 litres of paint can do 148 sqm of 2<sup>nd</sup> coat and *at the same time* it can also do  $6.17 \times 16 = 98.72$  sqm of 1<sup>st</sup> coat!

One more argument:

Let the answer be 4.

It means, it will require  $4 \times 4 = 16$  liters of paint.

Now, as per question:

1 liter can paint 16 sqm of first coat + 24 sqm of second coat.

For, 16 liters of paint, we can paint  $16 \times 16 = 256$  sqm of area for the first coat &  $16 \times 24 = 384$  sqm of area for second coat.

But we need only 148 sqm for first coat & 148 sqm for second coat.

So the answer 4 might not be correct

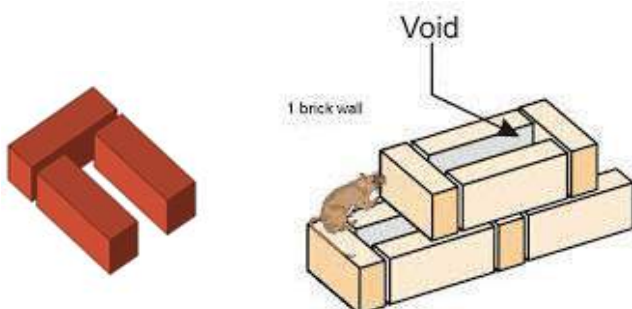
In the same way, we can crosscheck if the answer is 3.

Now, solve the following question:

**One litre of acrylic paint can cover 16 sqm of wall area for the first coat ‘OR’ 24 sqm for the second coat. The walls of a lecture hall measuring  $12\text{m} \times 8\text{m} \times 4\text{m}$  ( $L \times B \times H$ ) need to be painted with two coats of this paint. The hall has total glazed fenestration area of 12 sqm. The number of 4 litre paint containers required will be \_\_\_\_\_ ?**

**Q10. The estimated number of bricks (unit size:  $250\text{ mm} \times 125\text{ mm} \times 75\text{ mm}$ ) for laying one course of a 250 mm thick brick wall using rat-trap bond for a running length of 3.9 meter will be \_\_\_\_\_ (2 marks)**

Answer: 36



One set of rat-trap contains 3 bricks as shown whose overall length is  $75 + 250 = 325\text{mm}$ .

So, no. of brick set =  $3900\text{mm}/325\text{mm} = 12$  brick set.

So, no of bricks =  $12 \times 3 = 36$  bricks

**Q11. In 2001, the population and work force participation rate of a town were 30,000 and 30 percent respectively. The work force participation rate in the year 2011 increased to 34 percent. If the decadal population growth rate was 6 percent, the increase in the number of working people in the town in 2011 was \_\_\_\_\_ (2 marks)**

Solution: Working population in 2001 = 9000

In 2011, total population =  $30,000 + 6\%$  of  $30,000 = 31,800$

Now, 34% of 31,800 is the work force = 10812

So, increase in work force =  $10812 - 9000 = 1812$  Answer

**Q12. In a 20 storey building with 3m floor to floor height, a passenger lift is hoisted by a steel rope. Weight of the lift owned is 750 kg and ultimate load the steel rope can carry is 39,000 kg. Assuming a factor of safety of 20 for the steel rope and an average passenger weight of 75 kg, the passenger capacity of the lift is \_\_\_\_\_**

Solution: Usable strength of steel rope =  $39000/20 = 1950$  kg

Strength of steel rope considering liftcar weight =  $1950 - 750 = 1200$ kg

Capacity of lift =  $1200/75 = 16$  person Answer

**Q13. A room is mechanically ventilated through four air-conditioning ducts. The opening area of each duct is 0.35 sqm. The air velocity in the duct is 0.5 m/s. The temperature difference between the ambient air and supply air is 10 °C. Volumetric specific heat of air is 1250 J/m<sup>3</sup> °C. Assuming one Ton of refrigeration (TR) equals 3.5 kW, the cooling load of the room in TR will be \_\_\_\_\_ (2 marks)**

Solution: Total area of the duct =  $4 \times 0.35 = 1.4$  sqm

Total air volume in the room collected in 1 hr (3600 sec) =  $1.4 \times 0.5 \times 3600 = 2520$  cum

Total energy required =  $ms\Delta t = 2520 \times 1250 \times 10 = 31500000$  Joule

Load in TR =  $(31500000/3.5KW)/3600 = (31500000/3500)/3600 = 2.5$  Answer

**Q14. Find the reverberation time of room 4m x 3m x 3m (LBH) with the help of following data.**

	Wall		Ceiling		Floor
Percentage area	30	70	40	60	100
Absorption coefficient	0.4	0.1	0.6	0.1	0.1

Solution:  $t = 0.16 \cdot [(V/A)] = 0.16 [(4 \times 3 \times 3)/12.78] = 0.45$  Sec

Calculation of 'A'

Wall area = perimeter of wall x height =  $[2(4+3)] \times [3] = 42$  sqm = P

Ceiling area =  $4 \times 3 = 12$  sqm = Q

Floor area =  $4 \times 3 = 12$  sqm = R

So,  $A = P[(0.4 \times 30\%) + (0.1 \times 70\%)] + Q[(0.6 \times 40\%) + (0.1 \times 60\%)] + R(0.1 \times 100\%)$

$= P[(0.4 \times 0.3) + (0.1 \times 0.7)] + Q[(0.6 \times 0.4) + (0.1 \times 0.6)] + R(0.1 \times 1)$

$= 42[(0.4 \times 0.3) + (0.1 \times 0.7)] + 12[(0.6 \times 0.4) + (0.1 \times 0.6)] + 12(0.1 \times 1)$

$= 42(0.12 + 0.07) + 12(0.24 + 0.06) + 12 \times 0.1$

$= 42 \times 0.19 + 12 \times 0.3 + 1.2$

$= 7.98 + 3.6 + 1.2$

$= 12.78$

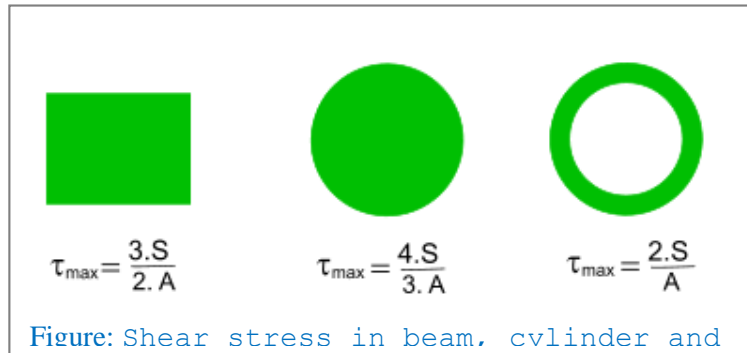
Answer: 0.45

**Q15. A four-storey building with equal areas in each floor is required to be designed on a plot with FAR of 2.0. If the FAR is increased to 2.2, the percentage increase in ground coverage utilizing full FAR in both cases will be \_\_\_\_\_ (2 marks)**

## GATE 2010

**Q.1 When shear stress exceeds the permissible limit in a RCC slab, then this problem is solved by**

- (A) Increasing the slab depth  
 (B) Providing shear reinforcement  
 (C) Using high strength steel  
 (D) Using thinner bars but more in number



Notes: Increasing the slab depth

Stress = Force/Area

So, If area is increased, stress will be decreased.

Area can be increased by increasing its depth.

A= Section area (m<sup>2</sup>)

S = Shear Force on Section (N)

**Answer: (A)**

**Q.2 Considering the total heat loss from all fluorescent lamps to be 79%, the Heating load (Btu/ hr) due to office illumination with 48 ceiling mounted luminaries, each containing four 40 W fluorescent lamps and flat surface diffusers will be**

- (A) 10000 Btu/ hr (B) 15000 Btu / hr (C) 17500 Btu/ hr (D) 21000 Btu / hr

Notes: The **British thermal unit** (symbol **Btu** or sometimes **BTU**) is a traditional unit of energy equal to about 1055 joules.

$$\begin{aligned} \text{Total heat generated by the Lamp} &= 0.79 \times 48 \times 40 \times 4 = 6067.2 \text{ Joule/sec} \\ &= 0.79 \times 48 \times 40 \times 4 \times 3600 = 218411920 \text{ joule/hr} \\ &= 218411920 / 1055 = 20703.24 \text{ Btu/hr} \\ &= 21000 \text{ Btu/hr} \end{aligned}$$

**Answer: (B)**

**Q.3 A square pin jointed truss is subjected to a load P, acting in the direction of member US, at joint U, The force in member UR is**

- (A) 1.414 P (B) 1.000 P (C) 0.707P (D) 0.000 P

Notes:  $P \times \cos 45 = 0.707P$

**Answer: (C)**

**Q.4 If the area of a plot is 1000 sq.m., area of its adjoining roads is 500 sq.m., maximum permissible FAR is 150 and maximum permissible Ground Coverage is 50%, then utilizing fullest ground coverage and assuming floors of equal area, the number of storeys that can be built on the plot is**

- (A) 6 (B) 4 (C) 3 (D) 2

**Answer: (C) 3**

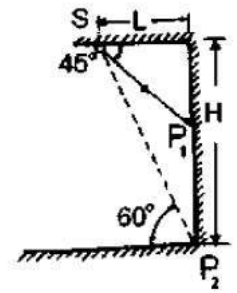
Solution: Plot area = 1000 sq.m.

Total floor area = 1.5 \* 1000 = 1500 sq.m.

Ground coverage = 50% of plot area = 0.5 \* 1000 = 500 sq.m.

So, no. of floors = Total floor area / Ground coverage = 1500 sq.m. / 500 sq.m = 3 Answer

**Q.5** In a display window of height  $H = 8.66$  m, of a retail store, a luminaire of intensity  $L$  is mounted at a distance = 5 m away from the rear. Its light beam is cast at an angle of  $45^\circ$  from the ceiling, as shown in the figure alongside.



The ratio of illumination at points  $P_1$  and  $P_2$

- (A)  $1:\sqrt{3}$  (B)  $\sqrt{3}:2$  (C)  $\sqrt{2}:1$  (D)  $1:2$

**Solution:** Let illumination at point S,  $P_1$  and  $P_2$  be  $I$ ,  $I_1$  and  $I_2$  respectively.

We have to calculate the value of  $I_1 / I_2$ . Obviously illumination at point  $P_1$  will be greater than illumination at point  $P_2$  because  $P_1$  is nearer to light source than  $P_2$ .

So, Value of  $I_1 / I_2$  will be always greater than 1. Therefore, option (A) and (D) is incorrect. Now we have to choose the answer from option (B) and (C).

Now, with simple calculation, you can find the distance of  $P_1$  from light source as  $5\sqrt{2}$ m and distance of  $P_2$  from light source as 10m.

So,  $I_1 = [I / (5\sqrt{2})^2] * \cos 45^\circ = [I / (5\sqrt{2})^2] * 1/\sqrt{2} = I / 50\sqrt{2}$

And  $I_2 = [I / (10)^2] * \cos 60^\circ = [I / (10)^2] * 1/2 = I / 200$

Therefore,  $I_1 / I_2 = (I / 50\sqrt{2}) / (I / 200) = 200 / 50\sqrt{2} = 4 / \sqrt{2} = 2\sqrt{2}$  Answer

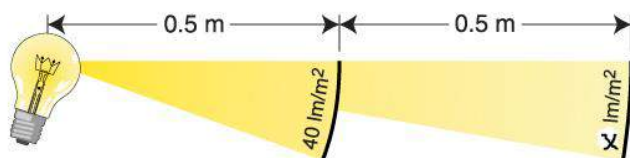
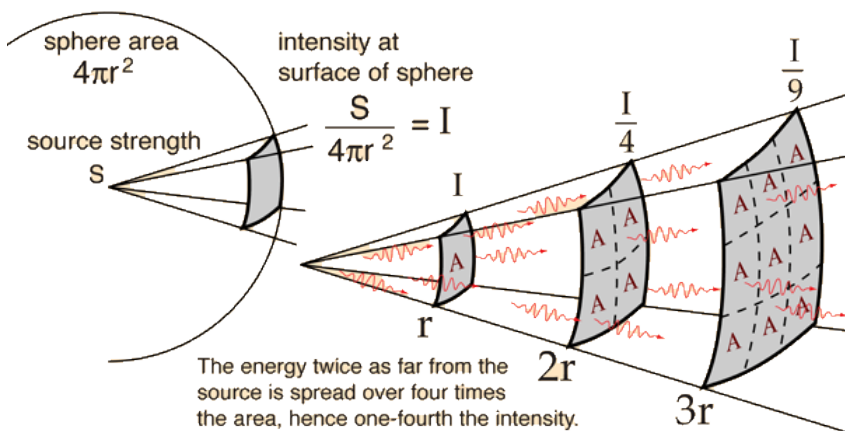
Answer : (None)

(Even if we ignore *Cosine Law of Illuminance* for a moment, the answer does not match to the options)

**Notes: The Inverse Square Law of Illuminance**

This law states that the Illuminance ( $E$ ) at any point is inversely proportional to the square of the distance between the source and plane.

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

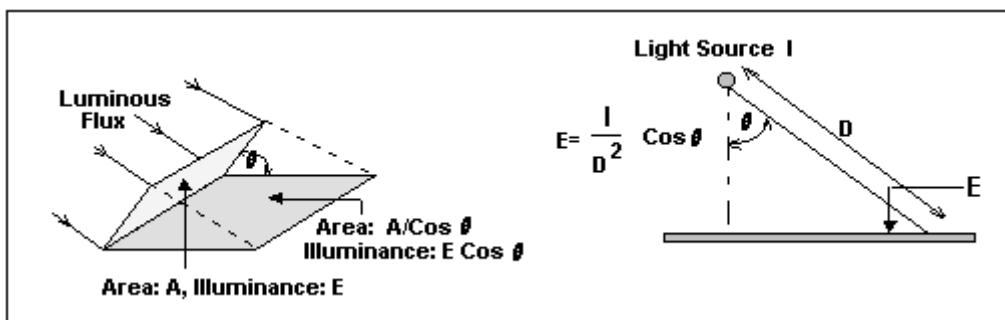


[Can you find the value of x ?]

**The Cosine Law of Illuminance**

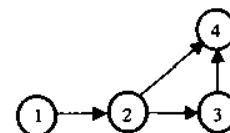
The law states that Illuminance at a point on a plane is proportional to the cosine of the angle of light incident (the angle between the direction of the incident light and the normal to the plane). It is given by the following formula:

$$E = \frac{I_\theta}{d^2} \cos \theta$$



**Q.6** Following figure shows network for a particular project consisting of four activities.

Normal duration and crash time for each activity are given below.

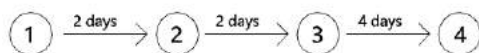


Activity	Normal duration (in days)	Crash time (in days)
1 - 2	3	2
2 - 3	4	2
2 - 4	5	4
3 - 4	7	5

The minimum time required for completion of project is

- (A) 9 days (B) 13 days (C) 14 days (D) 19 days

**Solution:** Minimum time will be calculated by the crash time of activities with longest path duration.



Here, we have total 9 days.

Notes: **Normal time ( $t_n$ ):** Normal time is the standard time that an estimator would usually allow for an activity.

**Crash time ( $t_c$ ):** Crash time is the minimum possible time in which an activity can be completed, by employing extra resources. Crash time is that time, beyond which the activity cannot be shortened by any amount of increase in resources.

**Normal cost ( $C_n$ ):** This is direct cost required to complete the activity in normal time duration.

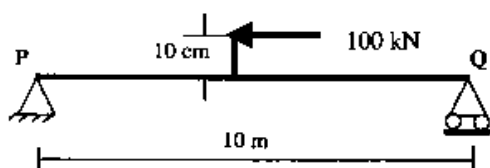
**Crash cost ( $C_c$ ):** This is the direct cost corresponding to the completion of the activity within crash time.

**Answer:** (A) 9 days

**Common Data Questions**

Common Data for Questions 7 and 8:

A simply supported beam PQ is subjected to a load of 100 kN through a rigid link at the centre of the beam as shown in the figure below



**Q.7** Correct shear force diagram for the beam is

(A) P-1, Q-2, R-2, S-2 (B) P-1, Q-2, R-1, S-1 (C) P-1, Q-2, R-2, S-1 (D) P-1, Q-1, R-2, S-2

**Q9. On street parking along a road kerb has provision for 45 degree angular parking with car spaces of 5.4 m by 2.5m. How many cars can be parked in 400m stretch along the kerb?**

(A) 100 cars (B) 110 cars (C) 120 cars (D) 130 cars

Answer: (B) 110 cars

Solution: Thumb rule for car space of 2.5m\*5m:

30° parking: ,  $L = 0.58 + 5N$

45° parking:  $L = 3.54 N + 1.77$

60° parking:  $L = 2.89N + 2.16$

**Q10. Moment at the fixed end 'A' of the beam indicated below is**

(A)  $-WL^2/12$  (B)  $-WL/16$  (C)  $-WL^2/8$  (D)  $-WL/8$

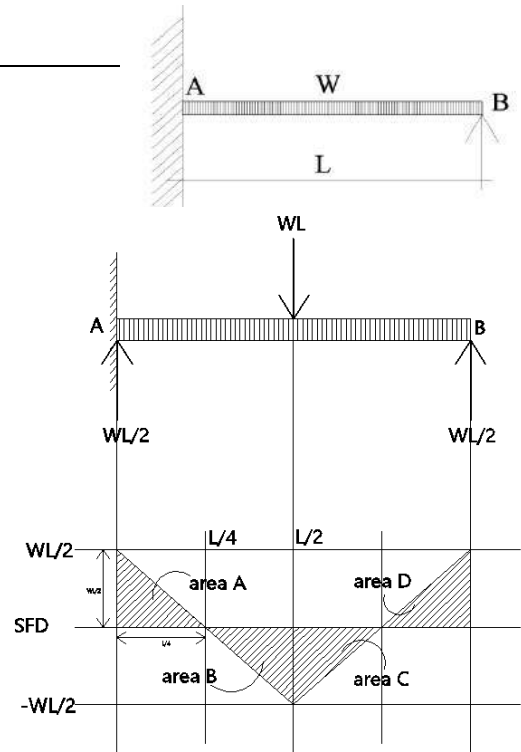
Solution: Let's start from the basic. Unit of Moment is Newton-meter. In the question, W is UDL (uniformly distributed load). So, its unit is Newton /meter. Unit of length L is meter.

Now, unit of WL is (W Newton/meter)\*(L meter) = WL Newton (which is essentially a force. So WL/16 is also a force, not a moment. Therefore options (B) and (D) are incorrect).

Now, you are left with options (A) and (D). You should try your luck. If not, you should know that the area in SFD (Shear Force Diagram) is actually a value of moment.

Here, Moment at A should be sum of area of triangle A & B.

Moment at A = Area ( $\Delta A + \Delta B$ ) = Area  $[(1/2 * WL/2 * L/4) + (1/2 * WL/2 * L/4)] = WL^2/8$  Answer



**Q11. A 300 meter long and 6 m wide pathway is to be illuminated with 4000 lumen lamps having maintenance factor of 0.8 and coefficient of utilization 0.45. The desired average lux on the pathway is 6. What should be the spacing between the lamps?**

(A) 20 m (B) 30 m (C) 40 m (D) 50m Answer: (B) 30 m

Solution: Area of the road to be illuminated = 300m x 6m = 1800sq.m.

We have,

$$E = (N \times F \times UF \times MF) / A$$

Where , E = average illuminance over the horizontal working plane

N = number of luminaire

F = lumens per lamp

UF = Utilisation Factor for the horizontal working plane

MF = Maintenance Factor

A = area of the horizontal working plane

$$\text{So, } 6 = (N \times 4000 \times 0.8 \times 0.45) / 1800$$

$$\Rightarrow N = 8 \text{ lamps}$$

$$\text{Spacing} = 300 / (8 + 1) = 33.3 \text{ Answer.}$$

Notes:

- Lumens measure total amount of light output
- Lux measure light intensity



Figure Lux meter

Here,  $ac$  is the virtual image of the chimney  $a'c'$ . We know the length of  $ac = 0.26$  cm and its scale is 1:10,000. Therefore, height of chimney  $a'c' = 0.26$  cm \* 10,000 = 26 meter **Answer.**

### 17. Explain the significance of 'Z' score in the statistical analysis and mention its properties.

Answer: **z Score**

A **z-score** (a **standard score**) indicates how many standard deviations an element is from the mean. A z-score can be calculated from the following formula.

$$z = (X - \mu) / \sigma$$

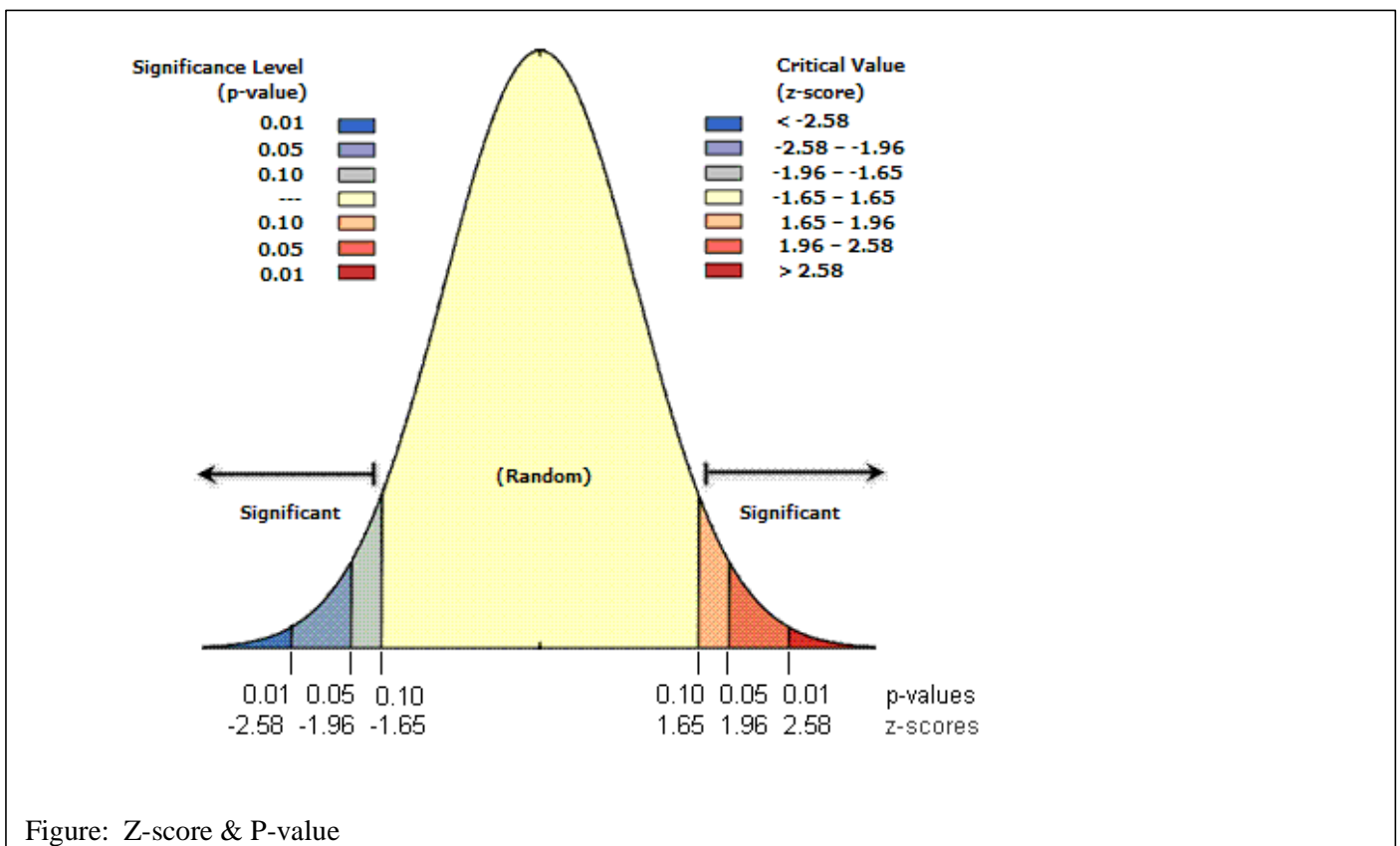
where  $z$  is the z-score,  $X$  is the value of the element,  $\mu$  is the population mean, and  $\sigma$  is the standard deviation.

Here is how to interpret z-scores.

- A z-score less than 0 represents an element less than the mean.
- A z-score greater than 0 represents an element greater than the mean.
- A z-score equal to 0 represents an element equal to the mean.
- A z-score equal to 1 represents an element that is 1 standard deviation greater than the mean; a z-score equal to 2, 2 standard deviations greater than the mean; etc.
- A z-score equal to -1 represents an element that is 1 standard deviation less than the mean; a z-score equal to -2, 2 standard deviations less than the mean; etc.
- If the number of elements in the set is large, about 68% of the elements have a z-score between -1 and 1; about 95% have a z-score between -2 and 2; and about 99% have a z-score between -3 and 3.

Here is another way to think about z-scores. A z-score is the normal random variable of a standard normal distribution .

(Source: <http://stattrek.com/statistics/dictionary.aspx?definition=z%20score>)



**END OF THE QUESTION PAPER**



Activities on the critical path	$t_o$ (days)	$t_m$ (days)	$t_p$ (days)	Mean $(t_o+4t_m+t_p)/6$	Standard Deviation, $\sigma$ $(t_p - t_o)/6$	Variance, $\sigma^2$ 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  $\sigma$  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  $\sigma$ . As per the Statistics, individual  $\sigma$  cannot be added together. In order to determine Critical Path SD, we have to first find Variance of the Critical Path.

$$\text{Variance (Critical Path)} = \text{Variance(A)} + \text{Variance(B)} = 2.79 + 5.15 = 7.94$$

As per the Statistics,  $\sigma$  can be determined by taking Square Root of Variance.

$$\sigma (\text{Critical Path}) = \text{Square root of } (\text{Var(A)} + \text{Var(B)}) = \text{Square root of } 7.94 = 2.82 \text{ Answer.}$$

**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/m<sup>2</sup> 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.**

**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.**

**10. The passenger demand during the two hours morning peak period along a bus route is 4000 passengers. The round trip time along the route is 50 minutes and the average vehicle occupancy is 75 passengers. Calculate the hourly flow of buses and the number of buses required to provide this flow assuming 5% of the buses will be under service and repair.**

**11. A city with population of 1,00,000 discharges sewage of 120 lpcd in a stream having a flow of 1 cu.m/sec. The BOD content in the up-stream before the out fall is 0.8 mg/lit. Calculate the BOD content of the stream in mg/lit just down stream of outfall.**

Solution: First, calculate discharge rate of sewage.

$$Q_w = (100000 \times 120 \text{ litres}) / (24 \times 3600 \text{ seconds}) = 139 \text{ litres/seconds} = 0.139 \text{ cu.m /sec}$$

$$L_w = 40 \text{ mg/lit (assumed)}$$

$$Q_r = 1 \text{ cu.m/sec (given)}$$

$$L_r = 0.8 \text{ mg/lit (given)}$$

$$L_0 = \frac{Q_r L_r + Q_w L_w}{Q_r + Q_w}$$

Where :

$L_0$  = Ultimate BOD at the point of waste discharge

$Q_r$  = Flow in the river upstream of the discharge

$L_r$  = Ultimate BOD of the river water

$Q_w$  = Flow of wastewater from the discharge

$L_w$  = Ultimate BOD in the discharged wastewater

$$L_0 = \frac{1 \text{ cu.} \frac{\text{m}}{\text{sec}} \times 0.8 \frac{\text{mg}}{\text{lit}} + 0.139 \frac{\text{cu.m}}{\text{sec}} \times 0.8 \frac{\text{mg}}{\text{lit}}}{(1 + 0.139) \text{ cu.m/sec}} = 0.8 \text{ mg/lit Answer}$$

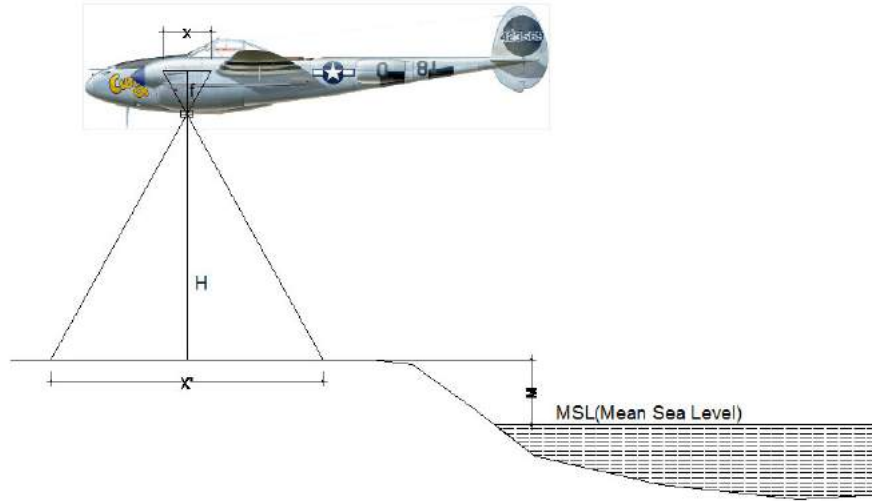
**12. Determine the angle at which a pavement should be banked in order to avoid outward sliding of vehicles along a horizontal circular curve of radius R= 300m. The maximum allowable speed limit along the curve is 100 km/hour. The coefficient of side friction is 0.2.**

Solution: *Given:* Coefficient of friction,  $\mu = 0.2$ , Radius,  $r = 300\text{m}$ , Speed  $v$ , = 100 km/hr = 27.78m/sec

13. Aerial photograph on scale 1:25000 was taken with an aerial camera lens of 15 cm focal length. Calculate the flying height above mean ground level of 1200 m. Find the flying height of the aircraft above mean sea level.

Solution: Here,  $\frac{f}{H} = \frac{x}{X'} \Rightarrow \frac{0.15\text{m}}{H} = \frac{1}{25000} \Rightarrow H = 25000 \times 0.15\text{m} = 3750\text{m}$  (Flying height above mean ground level)

Flying height of the aircraft above mean sea level =  $3750 + 1200 = 4950\text{m}$  Answer.



END OF THE QUESTION PAPER

1991

**Q1. Ratio 'Golden Mean' is:**

- (A) 1:2.261      (B) 1 : 1.618      (C) 1: 1.15      (D) 1: 1.44

**Q2. An urban area with a population of 2,15,000 is having housing stock of 39,000 and average household size of 5.0 . The city is expected to have 2,70,000 by 2001 with an average family size of 4.5, Estimate the housing demand of the city by 2001 assuming there will be depletion of existing housing stock by 3,500 during this period.**

Solution: Current Demand = Population / Household size = 2,15,000 / 5 = 43,000 Houses

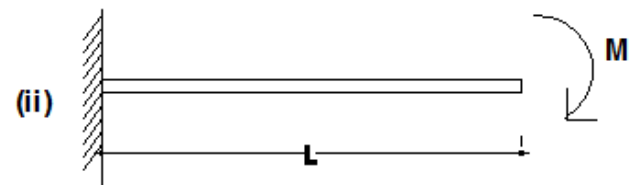
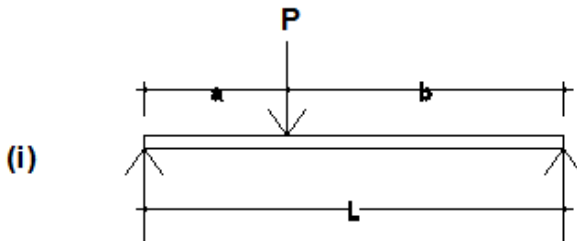
Housing Demand in 2001 = Population / Household size = 2,70,000 / 4.5 = 60,000 Houses

Demand difference = 60,000 – 43,000 = 17,000 Houses

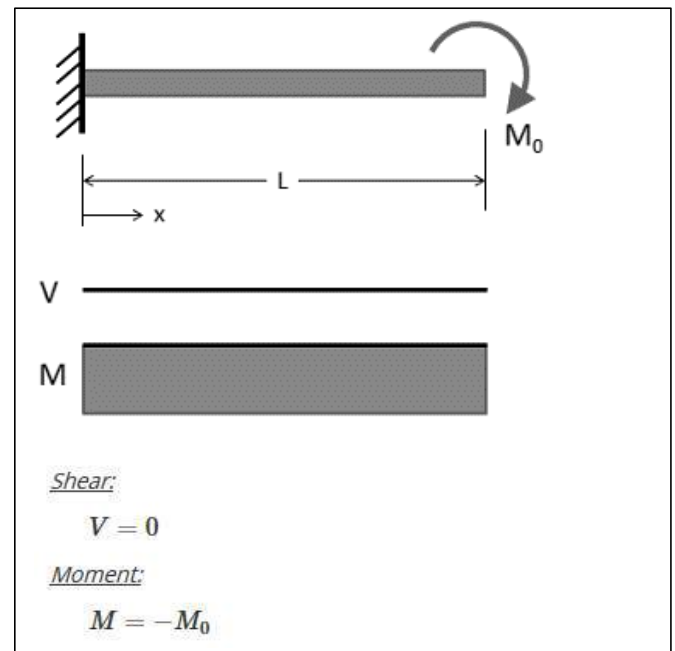
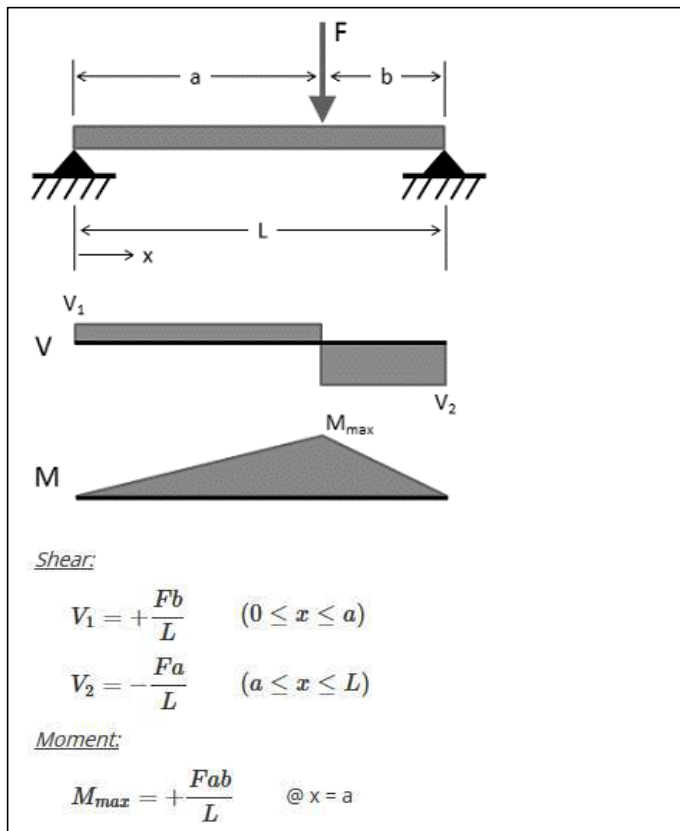
Initially we needed 43,000 houses but we had only 39,000. So, Initial Shortage = 43,000 – 39,000 = 4,000 Houses

Depleted Houses = 3,500 Houses

So, total demand = Demand difference + Initial shortage + Depleted houses = 17,000 + 4,000 + 3,500 = 24,500 Answer

**Q3. Draw the bending moment and shear force diagrams for the following:**

Solution:



**Q4. The residential landuse of an urban area accounts for 50% of the developed land of the city. The vacant undeveloped land is about 30% of the total urban area, which amounts to 2,400 hectares of land. Estimate the quantum of land put to residential uses and also the overall density of the urban area if the population is of 2,00,000 size.**

Solution: 30% of  $x = 2400 \Rightarrow \frac{30}{100} * x = 2400 \Rightarrow \frac{30*x}{100} = 2400 \Rightarrow 30*x = 240000$

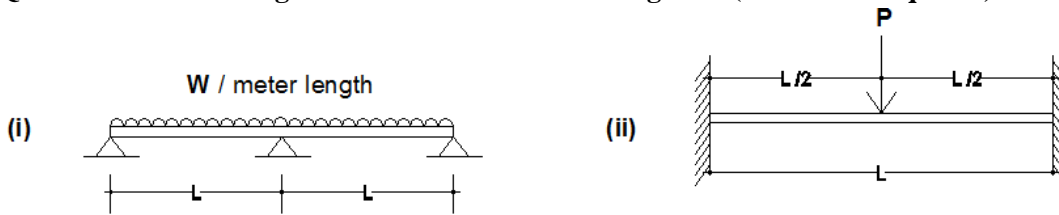
$\Rightarrow x = \frac{240000}{30} = 8000$  hectares ( It is total urban area)

As per question, 70% of total urban area is developed land = 70% of 8000 =  $\frac{560000}{100}$  hectare = 5600 hectare

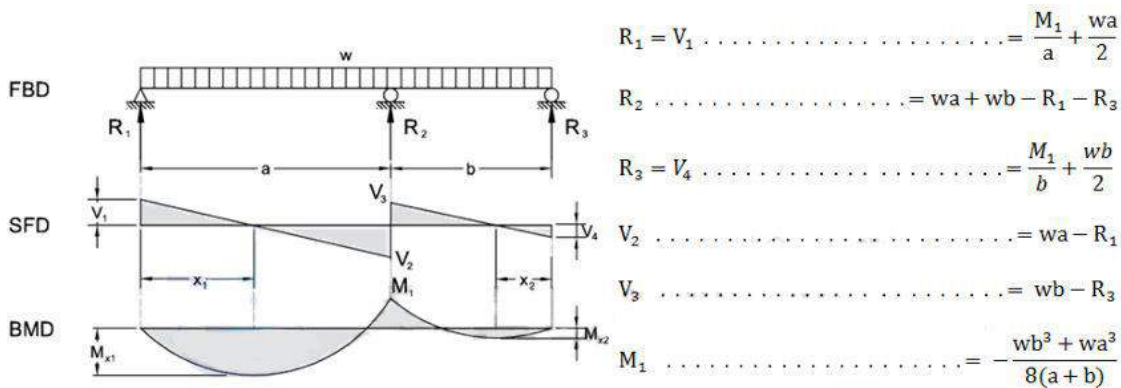
As per question, 50% of 5600 hectare is residential landuse = 2800 hectare *Answer*

Population density =  $\frac{\text{Population}}{\text{Total Area}} = \frac{2,00,000}{8000} = 25$  person per hectare *Answer*

**Q5. Sketch the bending moment and shear force diagrams (values not required)**

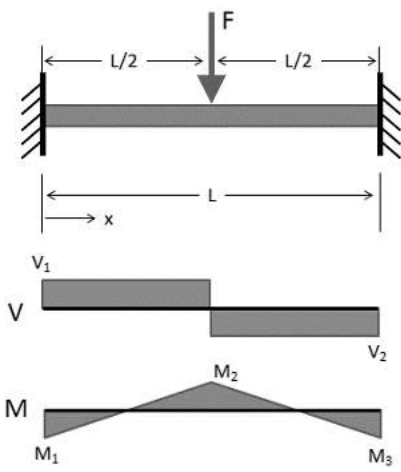


Solution:



$M_{x_1} \left( x_1 = \frac{R_1}{w} \right)$  .....

$M_{x_2} \left( x_2 = \frac{R_3}{w} \right)$  .....



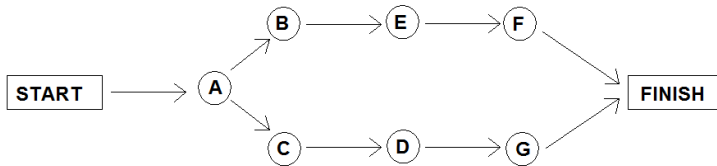
*Shear:*  
 $V_1 = + \frac{F}{2} \quad (0 \leq x \leq L/2)$   
 $V_2 = - \frac{F}{2} \quad (L/2 \leq x \leq L)$

*Moment:*  
 $M = \frac{F}{8} (4x - L)^2 \quad (0 \leq x \leq L/2)$   
 $M_1 = M_3 = - \frac{FL}{8} \quad @ x = 0 \text{ and } x = L$   
 $M_2 = + \frac{FL}{8} \quad @ x = L/2$

**Q6. Draw the CPM network diagram with the activities as shown below:**

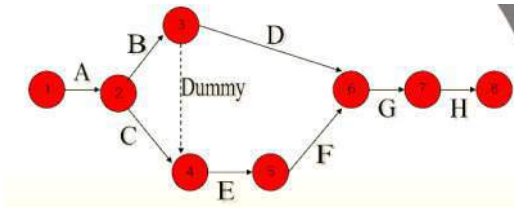
Serial No.	Activity	Preceding activity
1	A	-
2	B	A
3	C	A
4	D	C
5	E	B
6	F	E
7	G	D

Solution:



**Notes: Activity on Arc(AOA):**

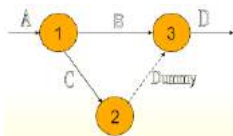
- Uses arcs to represent activities and nodes to represent events.
- It is Event Oriented.



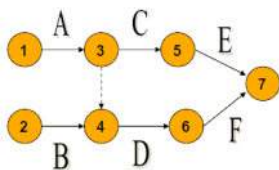
AOA approach requires the addition of a **Dummy Activity** to clarify the precedence relationships between the two activities. It is a zero time activity and consumes no resources.

Dummy Activity is used in two situations:

- 1) When two or more activities start and end at the same nodes.



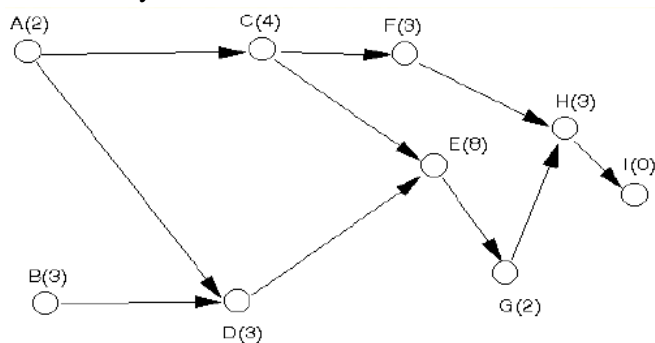
- 2) When two or more activities share the same precedence activity but not all the precedence are shared.



**Activity on Node (AON):**

Uses nodes to represent activities and arcs indicate precedence relationships between them.

It is Activity Oriented.



**END OF THE QUESTION PAPER**

## References

DCLG, Estimating housing need, November 2010

<http://www.pdhsite.com/courses/Rational%20Method%20Hydologic%20Calculations%20with%20Excel%20Course.pdf>

[http://www.lewishistoricalsociety.com/wiki/tiki-read\\_article.php?articleId=69](http://www.lewishistoricalsociety.com/wiki/tiki-read_article.php?articleId=69)

<http://nptel.ac.in/courses/105105104/pdf/m13134.pdf>

<http://www.izenbridge.com/blog/what-is-float-calculate-total-free-float/>

<http://www.goldennumber.net/>

<http://nptel.ac.in/courses/Webcourse->

[contents/IITROORKEE/strength%20of%20materials/lects%20&%20pics/image/lect23%20and%2024/lecture%2023%20and%2024.htm](http://nptel.ac.in/courses/Webcourse-contents/IITROORKEE/strength%20of%20materials/lects%20&%20pics/image/lect23%20and%2024/lecture%2023%20and%2024.htm)

<http://www.izenbridge.com/blog/what-is-float-calculate-total-free-float/>

<http://www.investopedia.com/articles/03/101503.asp>

<http://www.thermaxxjackets.com/sabine-modern-architectural/>

<https://www.translatorscafe.com/unit-converter/en/sound-pressure-level/>

<https://community.plm.automation.siemens.com/t5/Testing-Knowledge-Base/Sound-Pressure-Sound-Power-and-Sound-Intensity-What-s-the/ta-p/382834>

---

**Disclaimer:** We have made every effort to ensure that the information in this book was correct at press time, the author and the team do not assume and hereby disclaim any liability to any party for any loss, damage, or disruption caused by errors or omissions, whether such errors or omissions result from negligence, accident, or any other cause. Terms & conditions are applied. All references are sincerely acknowledged.

**END**

Click on the following links to buy or view the GATE NUMERICALS

**Buy on Instamojo**

<https://gatearchitecture.com/eshop/>

**Buy on Flipkart**

**Buy on Amazon**

Thank you