COMPLETE SET

GATE ARCHITECTURE 2020

BASED ON GATE SYLLABUS

9 BOOKS INSIDE

1500+ pages A4 Better Contents

- QUESTION BANK 1
- QUESTION BANK 2
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29 YEARS

- HISTORY & ARCHITECTURE
- URBAN PLANNING & DESIGN
- ARCHITECTS WORK
- BUILDING SERVICES, CONSTRUCTION & MANAGEMENT

By
Faculty of Architecture

gatearchitecture.com

PLEASE NOTE:

1. This is a preview. Only few pages are displayed. Total number of pages in this book (hard copy) is 1400+ pages.

2. This book is divided into 9 booklets for ease of reading.
   (a) QUESTION BANK 1 (Question Paper)
   (b) QUESTION BANK 2 (Question Paper)
   (c) QUESTION BANK 3 (Solution & Essential Notes)
   (d) QUESTION BANK 4 (Solution & Essential Notes)
   (e) QUESTION BANK 5 (Solution & Essential Notes)
   (f) Building Construction, Services & Management
   (g) Urban Planning & Design
   (h) History & Architecture
   (i) Architects Work

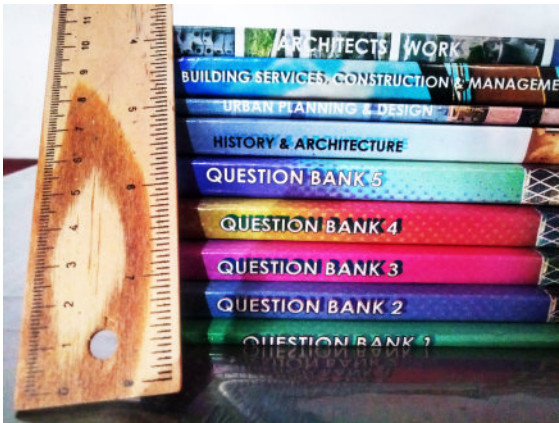
3. For Question Bank: The key to score for a good rank is to practice Mock Test. Sadly Mock Test often discourages.

So, we came up with a new strategy. We separated Question Paper from immediate solution. This way, the question paper serves as offline test paper for practice. This is the only Question Bank in the market with such unique way to achieve better result.

4. Contents of Topics, discussions, numericals etc. can be further included or excluded without prior information.

5. This the new edition for GATE 2020. All the shortcomings in the previous editions has been taken cared of.

ORIGINAL PHOTOGRAPHS:



Introduction

The best way to prepare for an exam like GATE is through comprehensive study of previous year question papers. It take less time to cover most part of the syllabus. Solving the previous year's GATE questions help aspirants to understand the exam pattern, knowing the level of questions and predict the pattern. At the same time you may be aware that just knowing the answers of previous year question paper is just not enough.

For example if the question is: The teahouse is a feature of which type of landscape architecture? And you learnt that the answer 'Japanese Garden'. It is best to support the answer with addition notes & figures about different types of gardens i.e. French, English, and Chinese etc. One reason for providing such notes is that it is rarely possible that in the next few years, the same question will be repeated. But it is quite possible that if a question is asked form related topic, you should answer it if you have gone through addition studies or notes.

Providing answer with essential notes & explanation is the main features of this Question Bank. It's been tried to cover the maximum part of the syllabus through providing supportive notes.

For further reading on particular topics, we have also provided QR codes & short links. Just scan or type the links to reach the web resources.

All illustrations are color printed. Paper published by National Center for Biotechnology Information, US suggests that there is positive effects of color illustration on cognitive process.

This question bank contains question papers of last 29 years from 1991 to 2019. All it makes it the complete question bank. When you go through all these, you will get an idea how question pattern and trend has changed over time. This will greatly help you to focus on the part of the syllabus which are frequently asked in exams.

This book should provide an edge to your study. Hopeful that it will make you confident and feel easy on question pattern. Best wishes for your preparation.

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

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Contents

QUESTION BANK

YEARS 2019 to 2013

GTAE Question Paper

PART 1

By
Faculty of Architecture

GATE ARCHITECTURE

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Q. 1 –Q. 5 Carry one mark each.

Q.1 The fishermen, _____ the flood victims owed their lives, were rewarded by the government.

(A) whom (B) to which (C) to whom (D) that

Q.2 Some students were not involved in the strike.

If the above statement is true, which of the following conclusions is/are logically necessary?

1. Some who were involved in the strike were students.
2. No student was involved in the strike.
3. At least one student was involved in the strike.
4. Some who were not involved in the strike were students.

(A) 1 and 2 (B) 3 (C) 4 (D) 2 and 3

Q.3 The radius as well as the height of a circular cone increases by 10%. The percentage increase in its volume is ____.

(A) 17.1 (B) 21.0 (C) 33.1 (D) 72.8

Q.4 Five numbers 10, 7, 5, 4 and 2are to be arranged in a sequence from left to right following the directions given below:

1. No two odd or even numbers are next to each other.
2.The second number from the left is exactly half of the left-most number.
3.The middle number is exactly twice the right-most number.

Which is the second number from the right?

(A) 2 (B) 4 (C) 7 (D) 10

Q.5 Until Iran came along, India had never been _____ in kabaddi.

(A) defeated (B) defeating (C) defeat (D) defeatist

Q. 6 –Q. 10 carry two marks each.

Q.6 Since the last one year, after a 125 basis point reduction in repo rate by the Reserve Bank of India, banking institutions have been making a demand to reduce interest rates on small saving schemes. Finally, the government announced yesterday a reduction in interest rates on small saving schemes to bring them on par with fixed deposit interest rates. Which one of the following statements can be inferred from the given passage?

(A)Whenever the Reserve Bank of India reduces the repo rate, the interest rates on small saving schemes are also reduced
(B)Interest rates on small saving schemes are always maintained on par with fixed deposit interest rates
(C)The government sometimes takes into consideration the demands of banking institutions before reducing the interest rates on small saving schemes
(D)A reduction in interest rates on small saving schemes follow only after a reduction in repo rate by the Reserve Bank of India

Q.7 In a country of 1400 million population, 70% own mobile phones. Among the mobile phone owners, only 294 million access the Internet. Among these Internet users, only half buy goods from e-commerce portals. What is the percentage of these buyers in the country?

(A) 10.50 (B) 14.70 (C) 15.00 (D) 50.00

Q.8 The nomenclature of Hindustani music has changed over the centuries. Since the medieval period *dhrupad* styles were identified as *baanis*. Terms like *gayaki* and *baaj* were used to refer to vocal and instrumental styles, respectively. With the institutionalization of music education the term *gharana* became acceptable. *Gharana* originally referred to hereditary musicians from a particular lineage, including disciples and grand disciples. Which one of the following pairings is NOT correct?

(A) *dhrupad, baani* (B) *gayaki,* vocal (C) *baaj,* institution (D) *gharana,* lineage

Q.9 Two trains started at 7AM from the same point. The first train travelled north at a speed of 80km/h and the second train travelled south at a speed of 100 km/h. The time at which they were 540 km apart is_____ AM.

(A) 9 (B) 10 (C) 11 (D) 11.30

Q.10 "I read somewhere that in ancient times the prestige of a kingdom depended upon the number of taxes that it was able to levy on its people. It was very much like the prestige of a head-hunter in his own community."
Based on the paragraph above, the prestige of a head-hunter depended upon _____

(A)the prestige of the kingdom (B)the prestige of the heads
(C)the number of taxes he could levy (D)the number of heads he could gather

Q. 1 - Q. 25 carry one mark each.

Q.1 Which of the following commands in AUTOCAD is used to create 3D solid between various cross sections?

(A) LOFT (B) MESH (C) XEDGES (D) PFACE

Q.2 Name the architect who criticized ornament in useful objects in his

(A) John Ruskin (B) H P Berlage (C) Adolf Loos (D) Walter Gropius

Q.3 A sanitary landfill is provided with High Density Poly Ethylene (HDPE) lining along the ground surface. This is provided primarily to prevent

(A) Bleaching (B) Leaching (C) Rodents (D) Plant growth

Q.4 Super-elevation of a road with pre-determined radius of curvature is primarily dependent on

(A) Altitude (B) Soil bearing capacity (C) Traffic volume (D) Design traffic speed

Q.5 In a mono-centric urban model, land rent is expected to

(A) diminish as one moves towards the center (B) diminish as one moves away from the center
(C) remain constant across the whole urban area (D) be unrelated with distance from center

Q.6 Fineness modulus of sand measures its

(A) Compressive strength (B) Grading according to particle size
(C) Bulking of sand (D) Ratio of coarse and fine sand

Q.7 The spherical surface of the geodesic dome comprises of

(A) Equilateral triangles of various sizes (B) Isosceles triangles of various sizes
(C) Equilateral triangles of uniform size (D) Isosceles triangles of uniform size

Q.8 The abrupt change or junction between two ecological zones is termed as

(A) Ecological niche (B) Ecosystem (C) Ecotype (D) Ecotone

Q.9 Complementary colours in a Munsell pigment colour wheel refers to

(A) Colours in alternate positions (B) Colours opposite to one another
(C) Colours adjacent to each other (D) A pair of secondary colours

Q.10 The closing syntax, for an executable command line in C or C++ program, is (A) : (B) , (C) ; (D) .

Q.11 The term 'Necropolis' refers to

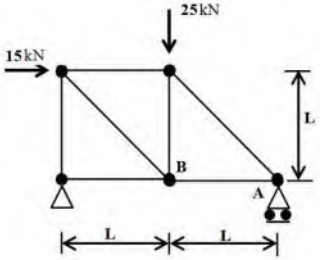
(A) Organically growing settlement (B) Origin of a settlement

Water depth = 600 mm
Manning's coefficient of roughness = 0.05
Slope along the drain = 1 in 250

Q.53 The stack pressure is created by 10 m height of stack and 15°C temperature difference. The motive force due to the stack pressure over a cross section area of 2.5 m^2 is _____ N.

Q.54 An industrial building contains 3000 kg of combustible materials, in dry state, distributed over three rooms of area 100 m^2, 500 m^2 and 300 m^2 each, in a proportion of 30%, 50% and 20% of the contents, respectively. Calorific value of the material is 4400 kCal/kg.
The Total Fire Load of the rooms is equal to _____ kCal/ m^2.

Q.55 A simple truss is shown in the figure below. The truss is loaded with horizontal and vertical force 15 kN and 25 kN, respectively. The force in the member AB will be _____ kN.



END OF THE QUESTION PAPER GATE 2019

Q. 1 – Q. 5 carry one mark each.

Q.1 "When she fell down the _____, she received many _____ but little help." The words that best fill the blanks in the above sentence are
(A) stairs, stares (B) stairs, stairs (C) stares, stairs (D) stares, stares

Q.2 "In spite of being warned repeatedly, he failed to correct his _____ behavior." The word that best fills the blank in the above sentence is
(A) rational (B) reasonable (C) errant (D) good

Q.3 For $0 \le x \le 2\pi$, 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) $(3\pi/2\ ,\ 2\pi)$

Q.4 The area of an equilateral triangle is $\sqrt{3}$. What is the perimeter of the triangle?
(A) 2 (B) 4 (C) 6 (D) 8

Q.5 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)

Q. 6 – Q. 10 carry two marks each.

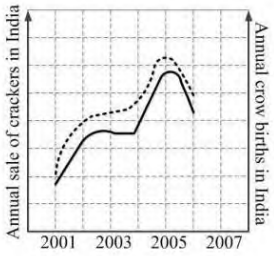
Q.6 An automobile travels from city A to city B and returns to city A by the same route. The speed of the vehicle during the onward and return journeys were constant at 60 km/h and 90 km/h, respectively. What is the average speed in km/h for the entire journey?
(A) 72 (B) 73 (C) 74 (D) 75

Q.7 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

Q.8 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

Q.9 If $x^2 + x - 1 = 0$ what is the value of $x^4 + 1/x^4$?
(A) 1 (B) 5 (C) 7 (D) 9

Q.10 In a detailed study of annual crow births in India, it was found that there was relatively no growth during the period 2002 to 2004 and a sudden spike from 2004 to 2005. In another unrelated study, it was found that the revenue from cracker sales in India which remained fairly flat from 2002 to 2004, saw a sudden spike in 2005 before declining again in 2006. The solid line in the graph below refers to annual sale of crackers and the dashed line refers to the annual crow births in India. Choose the most appropriate inference from the above data.



(A) There is a strong correlation between crow birth and cracker sales.
(B) Cracker usage increases crow birth rate.
(C) If cracker sale declines, crow birth will decline.
(D) Increased birth rate of crows will cause an increase in the sale of crackers.

Q. 1 – Q. 25 carry one mark each.

Q.1 In a Colour Wheel, Red and Blue colours are
(A) Tertiary (B) Complementary (C) Secondary (D) Primary

Q.2 In a bird's eye perspective view of a cuboid, the maximum number of vanishing points is
(A) 1 (B) 2 (C) 3 (D) 6

Q.3 The compressive strength of M-25 concrete is
(A) 25 kg/sqm (B) 25 N/sqmm (C) 250 N/sqmm (D) 2.5 N/sqmm

Q.4 In Critical Path Method (CPM) for time scheduling, 'forward pass calculation' is carried out for determining
(A) Late start and early finish time (B) Early start and early finish time
(C) Late start and late finish time (D) Early start and late finish time

Q.5 Collapse of the World Trade Center (WTC), New York, in 2001, was due to
(A) Wind load failure
(B) Foundation failure
(C) Thermal performance failure of reinforcement steel in RCC
(D) Thermal performance failure of structural steel

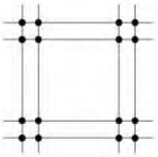
Q.6 During the construction of tall buildings, the equipment used for hoisting building materials to the upper floors is a
(A) Goods lift (B) Capsule lift (C) Gantry crane (D) Tower crane

Q.7 A Rock-cut style of architecture is represented by
(A) Shyama Rama Temple, Bishnupur (B) Kailasa Temple, Ellora
(C) Kandariya Mahadeva Temple, Khajuraho (D) Sanchi Stupa, Sanchi

Q.8 'Area based development' and 'Pan city development' are part of
(A) Smart City Mission (B) Digital India Mission
(C) Swachh Bharat Mission (D) Atal Innovation Mission

Q.9 In mass transportation, LRTS stands for
(A) Light Rail Transit System (B) Linear Rail Transit System
(C) Light Rail Transportation System (D) Linear Rail Transportation System

Q.10 The structural grid type shown in the figure is a



(A) Tartan Grid
(B) Square Grid
(C) Rectangular Grid
(D) Irregular Grid

Q.11 Assuming other variables remaining constant, the Tropical Summer Index
(A) Increases with increase in air velocity (B) Decreases with increase in wet-bulb temperature
(C) Decreases with increase in globe temperature (D) Increases with increase in vapour pressure

Q.12 Government of India's urban development program 'HRIDAY' stands for
(A) Heritage Rejuvenation Implementation Development Aayog Yojana
(B) Heritage Review Implementation Development Augmentation Yojana
(C) Heritage City Development and Augmentation Yojana
(D) Heritage City Improvement and Development Aawas Yojana

Q.13 As per the Urban and Regional Development Plan Formulation and Implementation (URDPFI) guidelines, the plan period considered in a 'Perspective plan' is
(A) 1-10 years (B) 11-15 years (C) 20-30 years (D) 35-45 years

Q.14 The Hall of Nations, New Delhi, was designed by
(A) Charles Correa (B) Raj Rewal (C) Joseph Allen Stein (D) A. P. Kanvinde

Q.15 As per the National Building Code of India 2016, the minimum turning radius (in metres) required for fire tender movement is
(A) 8.0 (B) 8.5 (C) 9.0 (D) 9.5

Q.43 The planning norms for provision of schools in a given town is shown in the table below

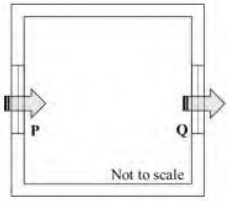
Schools	Population norm	Land requirement per school
Elementary School	One per 2500 persons	0.4 hectare
Primary School	One per 5000 persons	1.0 hectare
Secondary School	One per 12500 persons	2.0 hectare

Total land area required for providing all types of schools for a population of 200,000 is _____hectares.

Q.44 In a mixed use development on a 2.0 hectare site with 2.0 FAR, the ratio of residential to commercial floor area is 3:2. The minimum parking (in ECS) needed per 100 sqm of residential and commercial floor area is 1.0 and 1.25 respectively. Considering full FAR utilization, the total parking requirement is _____ECS.

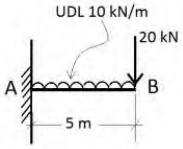
Q.45 A plotted housing scheme on a site of 12 hectare has 60% saleable area. The average unit cost of land development is INR 300 million per hectare. If the profit margin is 20%, then the selling price of land per hectare is_____million INR.

Q.46 An isolated enclosure shown in the Figure has inlet P and outlet Q of 2 sqm each, on the opposite walls. The outdoor wind speed is 5 m/sec. If the coefficient of effectiveness is 0.6, the rate of natural ventilation in the enclosure due to wind action is _____cum/hr.



Q.47 A 5m × 5m × 3m room has four 230 mm thick external brick walls. Total wall fenestration is 10 sqm. The temperature difference between indoor and outdoor is 2 degC. The air to air transmittance values for 230 mm thick brick wall and 200 mm thick aerated concrete block wall are 2.4 and 1.7 W/sqm degC respectively. If the brick walls are replaced with the aerated concrete block walls, then the change in conductive heat flow through the walls is_____W.

Q.48 For an activity, 'optimistic time duration' is 4 days, 'pessimistic time duration' is 11 days and 'most-likely time duration' is 8 days. The PERT value of time duration is days (up to one decimal place).



Q.49 In the Figure, the negative bending moment at point A of the cantilever is _____ kNm.

Q.50 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.

Q.51 In India, for 1.0 cum of M-20 grade concrete, the number of cement bags required is (up to two decimal places).

Q.52 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.

Q.53 The live load and dead load in a three storeyed residential building, transferred through a single column, is 12 tons and 18 tons respectively. If the soil bearing capacity is 10 ton/sqm and the factor of safety is 1.5, the area of column footing is sqm (up to one decimal place).

Q.54 The indoor illumination requirement for a building is 350 Lux. If the daylight factor is 2.7 and the design sky illuminance is 9000 Lux, then the required supplementary artificial lighting is _____Lux.

Q.55 Two design options of a business building on a 10.0 hectare site are being compared for built up area. Floor to floor height of Option A is 3.6 m and that of Option B is 4.5 m. If the maximum allowable building height is 45 m with same ground coverage for both options, the additional built up area achievable in Option A over Option B is percent.

END OF THE QUESTION PAPER GATE 2018

40. Match the following Urban Spaces in Group-I with their Names in Group-II

Group-I	Group-II
P. 	1. Piazza del Campo, Sienna
Q. 	2. Forum, Rome
R. 	3. Trafalgar Square, London
S. 	4. Agora, Athens
	5. St. Peter's Square, Rome

(A) P-4, Q-1, R-2, S-3 (B) P-2, Q-3, R-1, S-5 (C) P-4, Q-3, R-1, S-5 (D) P-2, Q-1, R-4, S-3

41. Match the terms in Group-I with the appropriate Items in Group-II

Group-I	Group-II
P Toposheet	1 Path/Row
Q Satellite Image	2 Contour
R Wavelength	3 Focal Length
S Scan Line	4 Spectral Signature
	5 Bits/inch

(A) P-5, Q-4, R-2, S-1 (B) P-5, Q-1, R-4, S-3 (C) P-2, Q-1, R-4, S-5 (D) P-2, Q-4, R-1, S-5

42. Match the Concepts in Group-I with their appropriate Explanation in Group-II

Group-I	Group-II
P Planned Unit Development	1 Development occurring on vacant or underused lots in otherwise built up areas
Q Infill Development	2 Development providing a fair and equitable way to integrate peri-urban areas
R Transit Oriented Development	3 Developing a large area as a single entity merging zoning and subdivision control
S Mixed Use Development	4 Development with compatible land uses integrating varied activities at different times of the day
	5 Development located within walking distance from mass transit stations along the corridor

QUESTION BANK

YEARS 2012 to 1991

GTAE Question Paper

PART 2

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Q.1. 'Agora' was provided in Greek towns as a place of
(A) Worship (B) Drama (C) Sports (D) Meeting

Q.2 The hue at the centre of the Munsell Colour Solid is
(A) Black (B) Grey (C) Sepia (D) White

Q.3 Which one of the following is NOT a traffic calming measure?
(A) Rumble strips (B) Roundabouts (C) Pedestrian crossings (D) Roadside trees

Q.4 ECBC stands for
(A) Electrical Conduit in Building Construction (B) Energy Conservation Building Code
(C) Electrical Credit in Building Code (D) Energy Credit in Building Construction

Q.5 Age-Sex cohort for a state in India is obtained from
(A) Census of India (B) Election Commission of India
(C) Indian Statistical Institute (D) Survey of India

Q.6 'Cover block' is used as a building construction component in
(A) Brick wall (B) Curtain wall (C) Steel truss (D) RC beam

Q.7 'Villa Savoye', Paris is an example of
(A) Modernism (B) Post Modernism (C) Deconstructivism (D) Eclecticism

Q.8 The least important measure for reducing cost of site development is
(A) Clustering the units (B) Eliminating landscaping costs
(C) Reducing road lengths (D) Narrowing road widths without reducing the right of way

Q.9 The role of a plasticizer in concrete is to improve
(A) Compressive strength (B) Permeability (C) Workability (D) Tensile strength

Q.10 Which one of the following causes seismic irregularity in a building?
(A) Rectangular plan shape (B) Vertical setback (C) Increase in height (D) Seismic joint

Q.11 The respective lengths of shadows generated for a free standing wall of given height L by sunlight incident at angles of 30°, 45°, 60°, 90° to the horizontal are
(A) L √3, L, L/√3, 0 (B) L, L √3, L/√3, 0 (C) L/√3, L, L √3, 0 (D) 0, L/√3, L, L √3

Q.12 Which one of the following mode is NOT categorized as a public transit?
(A) Bus (B) Ferry (C) Taxi (D) Tram

Q.13 Aerial photography is a useful tool to obtain
(A) Land contour data (B) Land cover data (C) Land ownership data (D) Landuse data

Q.14 Which one of the following is biodegradable?
(A) Detergent (B) Leather (C) Recycled plastic (D) Aluminum foil

Q.15 The volume of surface runoff is least influenced by
(A) existing storm water drainage system (B) amount of rainfall (C) site slope (D) size of watershed

Q.16 The best location for laying the main sewer line on a flat land is
(A) under the road (B) under the sidewalk
(C) under the central verge (D) under the open space along sidewalk

Q.17 Ponding is associated with
(A) RC column (B) Steel column (C) RC slab (D) Steel truss

Q.18 Among the following, the urban open space known for its human scale is
(A) Piazza del Campo, Sienna (B) Piazza del Popolo, Rome (C) St. Peter's Square, Rome (D) Place de la Concorde, Paris

Q.19 The most appropriate tree for designing a smell sensory pathway is

Q.61 Match the architectural term in Group I with their description in Group II

Group I	Group II
P. Trombe wall	1. A black water filled vessel absorbing solar radiation
Q. Brise-soleil	2. Glass enclosed space for sun bathing
R. Drum wall	3. Glass-front masonry wall absorbing solar radiation
S. Solarium	4. Screen to shield the interiors from sunlight

(A) P-3, Q-4, R-1, S-2 (B) P-4, Q-1, R-3, S-2 (C) P-3, Q-1, R-2, S-4 (D) P-2, Q-1, R-3, S-4

Q62. The three components of Christaller's theories of settlement system are

(A) Production, transport, centrality (B) Population, production, hierarchy

(C) Market, service, hierarchy (D) Production, market, transport

Q63. Match the valuation terms in Group I with their description in Group II

Group I	Group II
P. Scrap value	1. Value at the end of the utility period
Q. Salvage value	2. Value in present transaction
R. Market value	3. Value of dismantled material
S. Book value	4. Value after deducting the depreciation

(A) P-3, Q-1, R-2, S-4 (B) P-2, Q-3, R-4, S-1 (C) P-1, Q-2, R-3, S-4 (D) P-3, Q-4, R-1, S-2

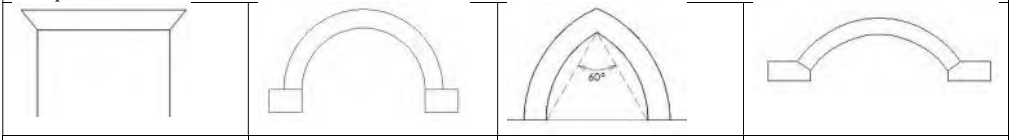
Q64. Match the urban forms in Group I with their descriptions in Group II

Group I	Group II
P. Satellite	1. Urban centre around large open space
Q. Constellations	2. Urban form around a main centre
R. Ring	3. Similar sized urban centres in close proximity
S. Radio centric	4. Circular form with radical corridors

(A) P-1, Q-3, R-4, S-2 (B) P-2, Q-3, R-1, S-4 (C) P-2, Q-4, R-3, S-1 (D) P-1, Q-2, R-3, S-4

Q.65 Match the arches in Group I with their names in Group II

Group I



P	Q	R	S

Group II			
1. Segmental	2. Equilateral	3. Flat	4. Semi-circular

(A) P-3, Q-1, R-4, S-2 (B) P-4, Q-1, R-2, S-3 (C) P-3, Q-4, R-2, S-1 (D) P-2, Q-3, R-1, S-4

Q66. The correct chronological sequence of the following building is:

(A) Lingaraj Temple > Sanchi Stupa > Padmanabhapuram Palace > Fatehpur Sikri > Gol Gumbaz

(B) Lingaraj Temple > Sanchi Stupa > Fatehpur Sikri > Padmanabhapuram Palace > Gol Gumbaz

(C) Sanchi Stupa > Lingaraj Temple > Gol Gumbaz > Fatehpur Sikri > Padmanabhapuram Palace

(D) Sanchi Stupa > Lingaraj Temple > Padmanabhapuram Place > Fatehpur Sikri > Gol Gumbaz

Q67. The components of energy embodied in a building material are

P. Obtaining government approval for quarrying

Q. Quarrying of the raw material

R. Transporting the raw material to the manufacturing unit

S. Manufacturing the building material

(A) P, R, S (B) P, Q, S (C) Q, R, S (D) P, Q, R

Q.30 Urushringa is the design component used in Shikhara of one of the following temple styles
(A) Bhubaneshwari (B) Dravidian (C) Khajuraho (D) Deccan

Q.31 Development that meets the needs of the present without compromising the ability of future generations to meet their own needs is
(A) Health, education and welfare development (B) Sustainable development
(C) Economic development (D) Infrastructure development

Q.32 Shell structure derives its strength primarily from its
(A) Shape (B) Wall thickness (C) Strength of the materials (D) Size

Q.33 The primary role of braces in a High-Rise building is to
(A) Resist the Gravity load (B) Restrict the lateral sway (C) Improve the elevation (D) Achieve large storey sway

Q.34 Weep holes refer to
(A) Internal duct in human anatomy connecting eyes and throat
(B) Rain water pipes connecting upper terraces to next lower one
(C) Holes made in a log to remove moisture
(D) Holes in retaining walls to allow water to drain out

Q.35 A structural device called pendentive is used in
(A) Closing the end of a vault (B) Decorating the corners of room
(C) Making a vault on a long passage (D) Making a dome on a square plan

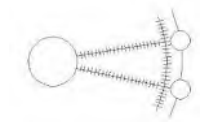
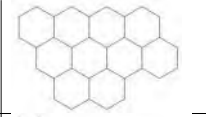
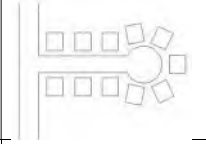
Q.36 The dome of the Gol Gumbaj at Bijapur is supported by
(A) Intersecting walls (B) Filling inside corners (C) Intersecting arches (D) Massive piers

Q.37 Match the type of building in Group I with their type of foundation in Group 2

Group I		Group II	
P.	Single storeyed	1.	Isolated footing
Q.	Three storeyed	2.	Raft foundation
R.	5 to 8 storeyed	3.	Pile foundation
S.	10 storeyed and above	4.	Well foundation

(A) P-1, Q-3, R-4, S-1 (B) P-4, Q-3, R-2, S-1 (C) P-1, Q-1, R-2, S-3 (D) P-2, Q-3, R-4, S-2

Q.38 Match the figure in Group I with the concepts in Group 2

Group I		Group II	
P.		1.	Christaller's concept
Q.		2.	Garden City concept
R.		3.	Multi nuclei concept
		4.	Radburn concept

(A) P-1, Q-3, R-4 (B) P-2, Q-1, R-4 (C) P-2, Q-3, R-1 (D) P-1, Q-3, R-2

Q.39 Match the period / style in Group I with their most significant contributions in the progress of architecture in Group 2

Group I		Group II	
P.	Egyptian	1.	New bonding material
Q.	Greek	2.	Building skeleton & skin
R.	Roman	3.	Trabeation
S.	Gothic	4.	Optical correction

(A) P-2, Q-1, R-3, S-4 (B) P-3, Q-4, R-1, S-2 (C) P-1, Q-2, R-3, S-4 (D) P-4, Q-3, R-2, S-1

Q.40 If the height of a building is *h* and distance of viewing is *d*, then *distance relation ratio* is given by *h:d*. Match the *h:d* in Group I with their characteristics in Group II

Group I		Group II	
P.	1:1	1.	Tend to see object as an edge
Q.	1:2	2.	Tend to notice details more than the facade
R.	1:3	3.	Tend to see object as a whole together with details
S	1:4	4.	Tend to see object in relation to surrounding objects

(A) P-2, Q-3, R-4, S-1 (B) P-2, Q-4, R-3, S-1 (C) P-1, Q-3, R-4, S-2 (D) P-4, Q-2, R-3, S-1

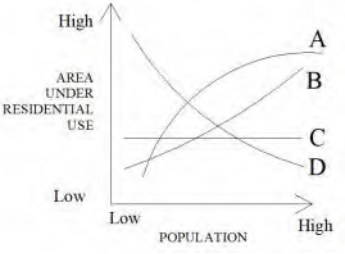
Q.41 Match AutoCad variables in Group I with their function in Group 2

Group I		Group II	
P.	Mirrtext	1.	Sets drawing units
Q.	Measurement	2.	Mirrors the text object
R.	Hidedtext	3.	Sets units for angles
S.	Aunits	4.	Controls how mirror command reflects text
		5.	Controls how visibility of text objects during hide command
		6.	Hide the text objects
		7.	Measures the distance between two points

(A) P-1, Q-1, R-5, S-3 (B) P-2, Q-7, R-6, S-3 (C) P-2, Q-7, R-5, S-1 (D) P-4, Q-7, R-6, S-1

Q.42 The correlation between population size of cities and area under residential use is depicted by the curves A, B, C, D. Choose the correct one.

(A) Curve A
(B) Curve B
(C) Curve C
(D) Curve D



Q.43 To describe the traffic characteristics of a city, show how you would identify the volume of

Group I		Group II	
P.	Peak hour traffic	1.	By quantifying traffic that stops within the city
Q.	Through traffic	2.	By determining the maximum hourly traffic volume
R.	Terminating traffic	3.	By observing the traffic that does not stop inside the city

(A) P-1, Q-2, R-3 (B) P-2, Q-3, R-1 (C) P-3, Q-1, R-2 (D) P-2, Q-1, R-3

Q.44 Match the typology of garden in Group I with their features in Group 2

Group I		Group II	
P.	Mughal garden	1.	Moss, manicured trees, rocks, water
Q.	Italian garden	2.	Cycle track, meandering walkways, benches
R.	Japanese garden	3.	Sculptures of pretty nymphs, angels, fountains
S.	City forest	4.	Geometrical floral patterns, flowing water, stone shelters

(A) P-1, Q-4, R-3, S-2 (B) P-3, Q-2, R-4, S-1 (C) P-4, Q-3, R-1, S-2 (D) P-2, Q-1, R-3, S-4

Q.45 Choose TWO abbreviations from the following that are very commonly used in transportation planning

	MOU		DJB
	DPC		PCU

	ROW		RAW
	ITI		EIA

(A) MOU, ROW (B) ITI, DJB (C) ROW, PCU (D) ROW, EIA

Q.46 Find the correct matches in the given list of architectural entities and the architectural style/period

Group I		Group II	
P.	Temple	1.	Mohenjodaro
Q.	Public bath	2.	Greek
R.	Agora	3.	Roman
S.	Granary	4.	Mayan

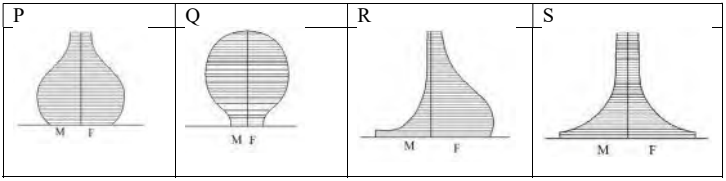
(A) Q-3, R-4 (B) Q-1, Q-3 (C) S-3, S-4 (D) P-2, P-3

Q.47 Stress due to bending moment may be computed through appropriate combination from the following parameters. Select the appropriate choice out of the ones given below.

M Bending moment	I Moment of Inertia
y Distance from neutral axis	E Young's modulus of elasticity
R Radius of curvature	σ Stress due to bending

(A) $\sigma R = yE$ (B) $MI = E\sigma$ (C) $\sigma I = MR$ (D) $\sigma y = ME$

Q.48 Match the shape of the age-sex pyramid and their interpretations.



1. City offers high employment opportunity
2. City's population is aging
3. City has poor employment opportunity
4. City has young population

(A) P-4, Q-1, R-2, S-3 (B) P-1, Q-2, R-3, S-4 (C) P-2, Q-3, R-4, S-1 (D) P-3, Q-4, R-1, S-2

Q.49 Choose the most appropriate design approaches that signify Laurie Baker's work

P. Recycling of materials
Q. Imaginative use of brick in construction
R. Innovative construction method to save cost
S. New vocabulary in indigenous construction

(A) P, R (B) Q, S (C) R, S (D) P, S

Q.50 A two colour / tone colour scheme is proposed for an office building. Which is the most appropriate set of combinations between the desired effect and the colour scheme?

Group I		Group II	
P.	Contrasting	1.	Complementary colours
Q.	Formal	2.	Extreme gray values
R.	Neutral	3.	Light colours

(A) P-2, Q-3 (B) Q-1, Q-3 (C) R-1 (D) P-1, P-2

Q.51 The efficiency of a modern housing scheme can be best assessed by

P. Efficient planning of a dwelling unit
Q. Better carpet area ratio
R. Imported finishes and fixtures
S. Good general common facilities

T. Good landscaping

(A) R, S, T (B) Q, S, T (C) P, Q, S (D) P, R, T

Q52. Given below are the statements related to AutoCad

Group I		Group II	
P.	Mspace: switches from model space to paper space	1.	True
Q.	Undo: restores last object erased	2.	False
R.	Multiple: Repeats the command you enter you press ESC		
S.	Layerp: restore a deleted layer		

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

Q53. The tract of land having a concave slope implies that

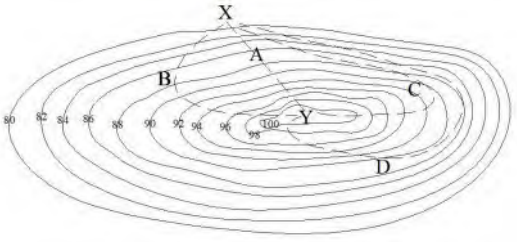
(A) Contour lines are spaced at decreasing distances in the downhill direction

(B) Contour lines are equally spaced

(C) Contour lines are spaced at increasing distance in the downhill direction

(D) There is no trend in spacing of contour lines

Q54. Given below is a sketch plan of a hilly site and two points to be connected by road. Select the best road alignment. Contour interval is 2 m.



(A) Alignment A

(B) Alignment B

(C) Alignment C

(D) Alignment D

Q55. Select the most appropriate sequence of the major space in a Hindu temple

(A) Antaral > Mandapam > Ardhamandapam > Garbhagruh

(B) Mandapam > Antaral > Ardhamandapam > Garbhagruh

(C) Garbhagruh > Antaral > Ardhamandapam > Mandapam

(D) Ardhamandapam > Mandapam > Antaral > Garbhagruh

Q56. Identify the devices from Group I that prevent sliding of truss roof components in Group II

Group I		Group II	
P.	Screw	1.	Battens
Q.	Bolt	2.	Purlins
R.	Wall plate	3.	Rafters
S.	Cleat	4.	Struts

(A) P-3, Q-4 (B) S-3 (C) S-2 (D) P-2, R-4

Q57. Choose the most appropriate set of facilities to be provided at the Sector level for about 20,000 inhabitants in a town of 3,25,000 inhabitants

P. High school **Q.** College **R.** Play field **S.** Shopping center **T.** Civic center

(A) P, Q, R (B) Q, R, T (C) P, R, S (D) Q, S, T

Q58. In different climate zones, different sets of devices are used to achieve comfort in a dwelling. Choose the most appropriate set.

Group I		Group II	
P.	Warm and humid	1.	Thick walls
Q.	Hot and dry	2.	Central courtyard
R.	Composite	3.	Thin walls
		4.	Small openings
		5.	Good ventilation
		6.	Evaporative cooling

(A) P-3, Q-6, R-4, S-5 (B) P-2, Q-1, R-4, S-5 (C) P-2, Q-1, R-6, S-3 (D) P-6, Q-1, R-2, S-4

Q65. Find out which of the following are TRUE (T) or FALSE (F) and choose the correct combination.

Group I		Group II	
P.	Housing loan amount is determined by repayment capacity	1.	True
Q.	The period of repayment of housing loans is never more than 7 years	2.	False
R.	In the villages, loans for house building is still taken from private sources		
S.	Housing loan packages are available from LIC, HUDCO, HDFC, CPWD & SBI		

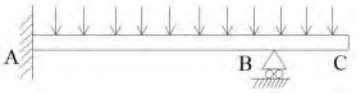
(A) P-1, Q-2, R-1, S-2 (B) P-2, Q-1, R-2, S-2 (C) P-1, Q-2, R-2, S-1 (D) P-2, Q-1, R-1, S-2

Q66. Match the quotation in Group I with their authors in group II

Group I		Group II	
P.	Form follows function	1.	Albert Einstein
Q.	Imagination is more important than knowledge	2.	Winston Churchill
R.	Form follows climate	3.	Louis Sullivan
S.	We shape the buildings thereafter they shape us	4.	Charles Correa

(A) P-1, Q-2, R-3, S-4 (B) P-3, Q-1, R-4, S-2 (C) P-2, Q-3, R-1, S-4 (D) P-4, Q-2, R-3, S-1

Q67. Referring to the Figure below, select the valid combination of symbols representing the parameters given below



Group I		Group II	
P.	Shearing force at point A	1.	Maximum value
Q.	Shearing force at point B	2.	Positive value
R.	Shearing force at point C	3.	Negative value
S.	Bending moment at point A	4.	Zero
T.	Bending moment at point B		
U.	Bending moment at point C		
V.	Torsion at point A		

(A) P-1, S-1, V-1 (B) R-4, U-3, T-2 (C) Q-1, T-3, V-4 (D) S-3, P-4, T-2

Q68. Identify the most appropriate sequence of processes used for treatment of waste water
(A) Skimming tank > Racks & screen > Precipitation tank > Sedimentation tank > Biological growth > Disinfection
(B) Biological growth > Racks & screen > Skimming tank > Sedimentation tank > Precipitation tank > Disinfection
(C) Racks & screen > Skimming tank > Sedimentation tank > Precipitation tank > Biological growth > Disinfection
(D) Biological growth > Skimming tank > Precipitation > Racks & screen > Sedimentation tank > Disinfection

Q69. A plot of land under development is located in a rocky area without any public sewerage system. Identify the most appropriate combination for sewage disposal for the proposed development.
P. Septic tank Q. Soak pit R. Anaerobic filter S. Oxidation
(A) P, Q (B) S, R (C) P, R (D) S

Q70. Match the elements of imageability with their most appropriate characteristics.

Elements		Characteristics	
P.	Node	1.	Strategic foci into which observer can enter
Q.	District	2.	Act as lateral reference and often path as well
R.	Landmark	3.	Area of homogeneous character recognised by clues
S.	Edge	4.	Singularity, contrast with its context. Observer does not enter in

(A) P-3, Q-1, R-2, S-4 (B) P-1, Q-3, R-4, S-2 (C) P-4, Q-3, R-1, S-2 (D) P-4, Q-3, R-2, S-1

Q71. The bio-climatic chart defines comfort zone in terms of
P. DBT
Q. Effective Temperature (ET)
R. Relative Humidity

S. Heat Stress Index

(A) P, Q, R (B) P, R (C) Q, S (D) P, R, S

Q72. Match the terms from Group I with the appropriate items in Group II

Group I		Group II	
P.	Town Planning Scheme	1.	Additional FAR granted to the developer if he provides public amenities / space
Q.	Transferable Development Right	2.	A legal procedure that allows pooling of land by owners, preparation of layout and redistribution of final plots.
R.	Incentive zoning	3.	Allows the plot owner to transfer the FAR/FSI on the area of the plot, surrounded to the local authority, to another plot

(A) P-3, Q-1, R-2 (B) P-2, Q-1, R-3 (C) P-2, Q-3, R-1 (D) P-3, Q-2, R-1

Q73. Match the housing programme in Group I with their key-features in Group II

Group I		Group II	
P.	KIP in Indonesia	1.	Participatory, stress on young beneficiaries' education
Q.	MHP of Sri Lanka	2.	Participatory, beneficiaries' contributed land
R.	Orangi project of Pakistan	3.	Employment generative, tenureship to beneficieries, in situ
S.	CDP of Hyderabad, India	4.	Flexible assistance, tenureship beneficiaries, in situ

(A) P-2, Q-4, R-1, S-3 (B) P-1, Q-2, R-3, S-4 (C) P-3, Q-1, R-2, S-4 (D) P-4, Q-3, R-4, S-3

Q74. Match the names of the tree in Group I with the shape of their leaves in Group II

Group I		Group II	
P.	Ticus religiosta	1.	
Q.	Cassia fistula	2.	
R.	Delonix regia	3.	
S.	Polyalthia longifolia	4.	

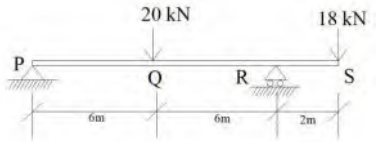
(A) P-3, Q-2, R-4, S-1 (B) P-4, Q-3, R-1, S-2 (C) P-3, Q-1, R-4, S-2 (D) P-2, Q-1, R-3, S-4

Q75. Match the Orders of Architecture in Group I with their most appropriate symbolic expression in Group II

Group I		Group II	
P.	Doric	1.	Floral
Q.	Iconic	2.	Most decorative
R.	Corinthian	3.	Masculine
S.	Composite	4.	Feminine

(A) P-3, Q-4, R-1, S-2 (B) P-2, Q-3, R-4, S-1 (C) P-4, Q-1, R-2, S-3 (D) P-1, Q-4, R-3, S-2

Q76. Referring to the structure shown in figure below, the maximum Shearing force in the beam is at point



(A) P (B) Q (C) R (D) S

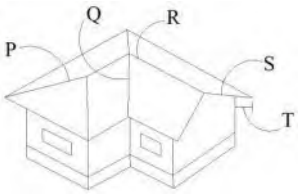
T. Stability

Which of the following combination of qualities is most appropriate for thermal insulation?
(A) P, Q, R (B) P, Q, S (C) Q, R, S (D) R, S, T

Q56. Sight lines are manipulated in the design of a complex by
P. Slight shifts in ground level
Q. Path directions
R. Position of opaque barriers
S. Some focal objects
T. Rising levels of middle grounds
Which of the following combinations provides the best manipulations?
(A) P, Q, R (B) Q, R, S (C) R, S, T (D)P, R, S

Q57. Following factors are considered for architectural design
P. Scale of different spaces
Q. location of elements
R. Topographical conditions
S. Structural system
Which of the following combination of factors is most suitable for proximity diagramming?
(A) R & S (B) Q & R (C) P & Q (D) P & S

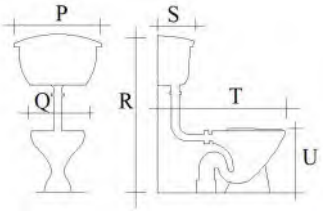
Q58. Which of the following combination correctly represent the labels indicated in the diagram given below?



	(A)	(B)	(C)	(D)
RIDGE	Q	R	Q	P
VALLEY	R	Q	R	Q
HIP	P	P	S	R
GABLE END	S	S	T	T
EAVES PROJECTION	T	T	P	S

Q59. Indicate the correct combination of dimensions against the labels shown below in the diagram of W.C. Dimensions are in centimetres.

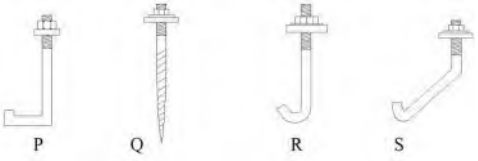
	(A)	(B)	(C)	(D)
P	70	30	55	75
Q	30	24	34	55
R	130	90	100	130
S	15	15	24	30
T	90	65	78	95
U	60	28	39	30



Q60. Indicate the correct combination of the duals of five platonic solids given below
T- TETRAHEDRON
C- CUBE
O- OCTAHEDRON
I- ICOSEHEDRON
D- DODECAHEDRON

(A)	(B)	(C)	(D)
T-T	T-O	T-D	T-I
C-O	C-D	C-C	D-D
I-D	I-I	I-O	O-C

Q61. Indicate the correct combination of names of the following bolts



	(A)	(B)	(C)	(D)
P	L-Bolt	Wood Bolt	Rectangular Bolt	Crank Bolt
Q	Coach Screw	Wood Screw	Needle screw	Coach Screw
R	Purlin bolt	J- Bolt	Hook bolt	Hook Bolt
S	Left Crank Bolt	Left Hand Bolt	Skewed Bolt	Cranked Hook Bolt

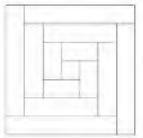
Q62. Match the following landscape architects listed in Group A with their works listed in Group B

Group I		Group II	
P.	Andre Le Notre	1.	Varsailles, France
Q.	Valladier	2.	The Piazza del Popolo, Rome
R.	John Wood	3.	The Regents Park
S.	John Nash	4.	Palace de la Concorde
		5.	Terrace Trivoli Garden
		6.	The Royal Cresent & Circus at Bath

(A) P-3, Q-4, R-6, S-5 (B) P-1, Q-2, R-6, S-3 (C) P-3, Q-2, R-4, S-6 (D) P-3, Q-2, R-6, S-5

Q63. Identify two attributes which best describes to the works of Michael Graves
P. Anthropomorphic
Q. Aesthetic irony
R. Traditional symmetry
S. Symbolic
(A) P, S (B) P, S (C) Q, R (D) R, S

Q64. Select three important factors from the following, which were considered by Louis I. Khan in his works
P. Materials and the ways they can be joined together
Q. Heights
R. Sensitivity to light
S. Grand spaces
T. Glass & steel
(A) PQR (B) PRS (C) RST (D) PST



Q65. The abstract form, shown below, of an Ancient Indian settlement represents
(A) Kurmaka (B) Nandyavarta (C) Padmaka (D) Swastika

Q66. Match the following commands in the AUTOCAD

Group I		Group II	
P.	REVSURF	1.	Reverses the last command
Q.	SURFTAB	2.	Makes a view portable to other software applications
R.	VIEWPORT	3.	Revolves an entry
S.	SHX	4.	Opens another window
		5.	Surfing the table generated
		6.	Assigning the mesh density
		7.	Related to shape file

(A) P-1, Q-5, R-2, S-6 (B) P-2, Q-6, R-4, S-5 (C) P-5, Q-3, R-7, S-4 (D) P-3, Q-6, R-4, S-7

Q73. Match the following paints in Group I against their most important quality as mentions in Group 2

Group I		Group II	
P.	Cement paint	1.	Water proofing
Q.	Plastic Emulsion paint	2.	Glossy appearance
R.	Oilbound Distemper	3.	Decorative appearance
S.	Synthetic Enamel paint	4.	Easily washable
		5.	Fire resistant
		6.	Acid resistant

(A) P-1, Q-3, R-4, S-5 (B) P-2, Q-3, R-5, S-3 (C) P-1, Q-6, R-3, S-4 (D) P-2, Q-1, R-4, S-6

Q74. Strips of two different metals firmly joined together as shown in the figure.

Select the changed profile of the joined strips, while heated, from the figure shown below.

(A) P (B) Q (C) R (D) S

Q75. Match the propagator with the following concepts.

Group I (Propagators)		Group II (Concepts)	
P.	Total architecture	1.	Patrick Geddes
Q.	Ekistics	2.	Jean Gottman
R.	Megalopolis	3.	Doxiadis
S.	Radburn	4.	Walter Gropius
T.	Conservative surgery	5.	Clarence Stein

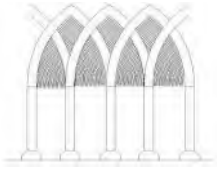
(A) P-4, Q-3, R-2, S-5, T-1 (B) P-3, Q-4, R-2, S-5, T-1 (C) P-5, Q-2, R-4, S-1, T-3 (D) P-4, Q-5, R-3, S-2, T-1

Q76. In Gandhi Smarak Saangrahalaya architect Charles Correa used different types of finishes. Select the combination of finishes used in the building.

P. Stone cladding
Q. Exposed brick
R. Plastering & painting
S. marble chips finish
T. Exposed concrete
U. Plain cement concrete finish

(A) R, S, T (B) Q, T, U (C) P, Q, R (D) Q, R, S

Q77. Match the correct names of the architectural styles and periods.

			
P	Q	R	S
1	2	3	4
Moorish Style 15^{th} Century	Romanesque Style 11^{th} – 12^{th} Century	Gothic Style 13^{th} – 14^{th} Century	Renaissance Style 15^{th} – 16^{th} Century

(A) P-1, Q-2, R-3, S-4 (B) P-2, Q-4, R-4, S-1 (C) P-1, Q-3, R-4, S-1 (D) P-2, Q-1, R-2, S-2

Q78. A 4 cm x 4 cm area on a map represented a land area of 16 hectares of ground. If this map is transformed to a scale of 1:5000 the same ground area will be represented by

(A) 80 sqm (B) 32 sqm (C) 64 sqm (D) 40 sqm

Q79. The figures 1 and 2 represent two different cases of buildings forms, building layouts and site features on sites located respectively in hot-humid and hot-dry regions. Considering the factors listed below which of the following options compared best the relative pressure and absence of these factors in the two cases.

Factors:
V- Cross Ventilation
P- Privacy in outdoor space
E- Exposure to outside view

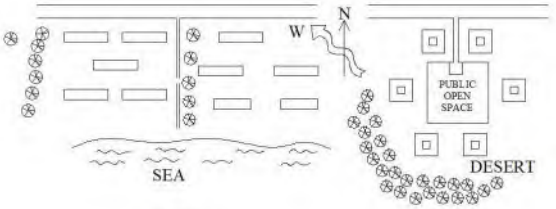
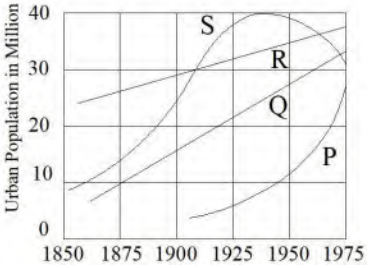


Figure 1 Figure 2

(A) Figure 1 has more V, more P and better E than Figure 2
(B) Figure 2 has less V, more P and better E than Figure 1
(C) Figure 2 has more V, more P and less E than Figure 1
(D) Figure 1 has more V, less P and better E than Figure 2

Q80. The graph below shows urban population growths of four countries (P, Q, R and S) with time.
Which of the following statements is INCORRECT?
(A) Urbanisation started much later in 'P' than in 'S' and it has achieved lower growth rate.
(B) Growth rate is higher in 'Q' than in 'R'
(C)Growth rate has been higher in 'P' than in 'Q', 'R', 'S' after 1900
(D) Urban population is higher in 'R' than in 'Q'



Q81. The following figures show four different unmanaged traffic intersections in a city.

Which of the following statements shows the correct numbers of potential traffic conflict points (excluding merging points) at the intersections?

(A) P-8, Q-3, R-3, S-2
(B) P-16, Q-3, R-3, S-0
(C) P-8, Q-3, R-3, S-0
(D) P-16, Q-3, R-3, S-2

Q82. Arrange the sequence of events in a Residential site development
P. Levelling and land filling
Q. Trees and plantation
R. Electrification
S. Allotment
T. Provision of roads
U. Provision of water supply, sewerage and drainage
(A) R, S, T, U, P, Q (B) P, R, S, U, T, Q (C) Q, P, S, R, T, U (D) P, T, Q, U, R, S

Q83. Indicate the correct match for items given in Group I with items given in Group II

Group I		Group II	
P.	Stone	1.	Pitting
Q.	Timber	2.	Mottle
R.	Brick	3.	Chalking
S.	Lime	4.	Star shake
		5.	Unburnt
		6.	Cracking

(A) P-2, Q-4, R-5, S-1 (B) P-2, Q-3, R-1, S-6 (C) P-3, Q-1, R-5, S-2 (D) P-1, Q-3, R-4, S-2

Q84. Which is the correct match for items given in Group I with items given in Group II

Group I		Group II	
P.	Thermal inversion	1.	Water repellent
Q.	Efflorescence	2.	Stable airflow
R.	Hydrophobic surface	3.	Lecture Hall
S.	Psychedelic effect	4.	Crystallization
		5.	Globulation

(A) P-2, Q-4, R-1, S-3 (B) P-2, Q-3, R-4, S-1 (C) P-1, Q-4, R-3, S-1 (D) P-5, Q-3, R-1, S-2

Q85. A general hospital has the following functional areas.
P. Entry
Q. Emergency
R. Out Patient Department
S. In Patient Department
T. Diagnostic Therapeutic Unit
U. Incinerator
V. Mortuary
W. Kitchen & Laundry
Select from the following group of pairs the one you consider as most appropriate designing the hospital.
(A) PR, QW, RS (B) PR, ST, RT (C) RT, PU, RV (D) RV, UV, QR

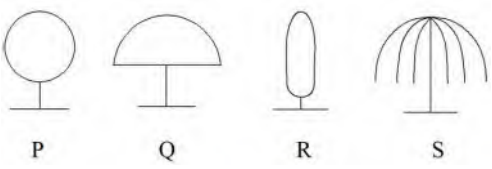
Q86. In high-rise building the walls are built thinner as they get higher. Select the most important pair of factors.
P. Thinner wall has less weight to bear at the top
Q. Thinner walls are suitable for earthquake
R. Thinner walls look beautiful
S. Thinner walls can take electrical conduit pipe easily
T. Thinner walls have moment of inertia
(A) P, R (B) P, Q (C) R, S (D) Q, T

Q87. In the landscape drains correlate the drain types with their positive or negative attributes and select the appropriate combinations.

Group I		Group II	
P.	Open drain	1.	Economic
Q.	Swale	2.	Easy collection
R.	French drain	3.	Susceptible to clogging
S.	Pipe drain	4.	High rate of flow
		5.	Easy maintenance
		6.	Visual scar

(A) P-1, 2, 4, 6 (B) Q-2, 3, 6, 4 (C) R-1, 2, 5, 6 (D) S-1, 4, 5, 6

Q88. Match the tree forms with their corresponding functions as listed below.
Functions:
1. Visual screening
2. Shading of functions around
3. Backdrop
4. Waterside edge planting
5. Boundary edging of a functional area
6. Scale induction of the adjoining object

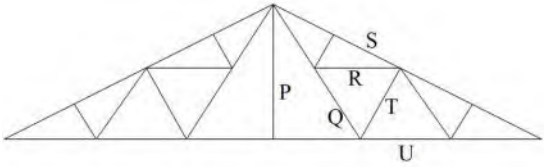


(A) P-3, Q-1, R-5, S-2 (B) P-1, Q-3, R-4, S-6 (C) P-1, Q-2, R-5, S-4 (D) P-3, Q-6, R-1, S-4

Q89. The Age-Sex pyramid of an urban area shows a bulge in the age group of 15 to 25.
Select the likely correct group of inference.
P- Birth rate has fallen

Q- In-migration is high
R- Out-migration is high
S- Death rate has fallen
T- Males are more the females
(A) P-Q (B) P-R (C) R-T (D) S-T

Q90. Truss elements are marked in the following drawing. Match them with the list given below.
1. Rafter
2. Strut
3. King post
4. Diagonal tie
5. Flat tie
6. Support
7. Main tie



(A) P-1, Q-2, R-3, S-4, T-5, U-6 (B) P-3, Q-1, R-3, S-6, T-7, U-4
(C) P-3, Q-4, R-5, S-1, T-2, U-7 (D) P-2, Q-4, R-5, S-7, T-6, U-3

Q91. Select the items in the Group I which matches most appropriately with the items of Group II

Group I		Group II	
P.	Air delivery system	1.	Adsorption
Q.	Air distribution system	2.	Dampers
R.	Dehumidification	3.	Spray washers
		4.	Diffusers
		5.	Dry filter

(A) P-1, Q-3, R-5 (B) P-2, Q-4, R-1 (C) P-2, Q-4, R-3 (D) P-1, Q-2, R-3

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Q.63 Poor academic performances of school children were attributed to missing breakfast and subsequent malnutrition. The investigating survey schedule questioned every student, how many days the students have missed the breakfast? Their response may be referred as
(A) nominal scale (B) ordinal scale (C) longitudinal scale (D) interval scale

Q.64 A site map shows five contour lines. A line drawn across the lowest the highest contour measures 125 m and has a slope of 8%. Determine the contour interval
(A) 5 m (B) 2.5 m (C) 10 m (D) 2 m

Q.66 In energy technology, efficiency is equal to energy output by energy input. If the efficiency level of a particular fossil fuel is 90% and the mechanical efficiency of the vehicle is 25% then how much is the total efficiency of the vehicle?
(A) 62.5% (B) 22.5% (C) 33.33% (D) 82.5%

Q67. Identify the components of Geographical Information System
P computer system and software
Q spatial data
R uniform energy source
S a super sensor
T real time data handling system
U data management and analytical tools
(A) P,Q,R,S,T,U (B) P, Q,S,U (C) P,Q,U (D) P, S ,T, U

Q68. The Bahai Temple at New Delhi has a Lotus Plan. The Louis has *x* number of petals, *y* number of equal angles and *z* type of architectural tradition. Which of the following is correct?

Type	x	y	z
(A)	12	30°	Egyptian Mastaba
(B)	9	40°	Persian Sepharial
(C)	10	36°	Santa Sophia, Turkey
(D)	8	45°	Ideal City of Vincenzo Scamozzi

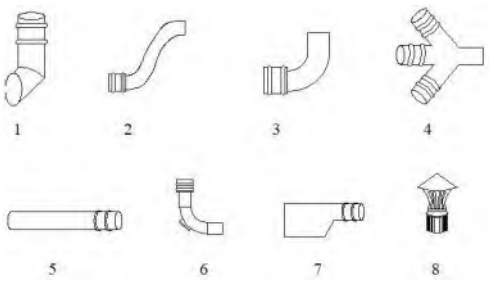
Q69. Michael Wilford, Peter Salter and Richard Rogers are associated with
(A) Potsdamer Plaza (Berlin), Kyoto Center (Japan), Music School and Theatre Academy (Stuttgart)
(B) Marylenbone Gale (UK), Islamic Arts Center (London), Stonhenge Visitors Club (UK)
(C) Reich Slag (Berlin), Camden Arts Center (France), Tate Gallery (Cornwall)
(D) Fountain Abbey Visitors Center (Yorkshire), Flat Conversion (London), More Cambe (UK)

Q70. Match the followings shown in Group 1 with the sketches shown in Group 2

Group 2

P Single socketed pipe
Q Double equal junction
R Pipe-shoe
S Reducing piece

Group 2



(A)	(B)	(C)	(D)
P- 5	P- 4	P- 8	P- 3
Q- 4	Q- 2	Q- 6	Q- 1
R- 1	R- 7	R- 5	R- 2
S- 7	S- 5	S- 1	S- 7

Q71. Which is the correct match for items given in Group I with items given in Group 2?

Group I		Group II	
P	Plastering	1	Volume
Q	Earthwork	2	PERT
R	Reinforcement	3	Schedule of Bending
S	Management	4	Area
		5	Temperature

(A) P-4 , Q-1 , R-3 , S-2 (B) P-2 , Q-1, R-3 , S-4 (C) P-3 , Q-5 , R-2 , S-4 (D) P-2 , Q-3 , R-4 , S-5

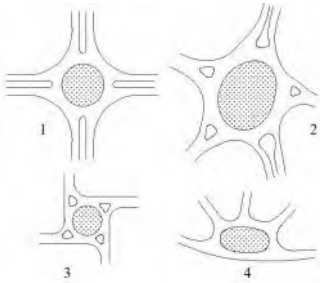
Q.72 Match the attributes with the corresponding shape of central island in a rotary shown in the sketches below

P reduction of vehicular speed on entering rotary and enable speeding of going out vehicle

Q enables excessive speeding of vehicles

R where two equally important roads cross

S accommodates four or more intersecting roads and allows greater traffic flow along direction of elongation



(A) P-3 , Q-4 , R-1 , S-2 (B) P-1 , Q-2, R-3 , S-4
(C) P-4 , Q-2 , R-4 , S-1 (D) P-3 , Q-4 , R-2 , S-1

Q.73 Identify the attributes that apply to sanitary landfill

P waste is deposited in 0.90 m - 4.50 m thick layers
Q low lying marshy waste land are transformed into useful areas
R attract flies, insects, and rodents
S causes health and pollution hazards
T chances of fire hazard in wet weather
U skilled personnel are required
V semi-skilled personnel are required
(A) R, S, T, U (B) P, Q, T, V (C) P, Q, S, T (D) Q, R, S, T

Q.74 Match the urban forms in Group I with corresponding urban areas in Group 2

Group I (Urban form)		Group II (Urban area)	
P	sheet	1	Delhi
Q	star	2	Tokyo
R	ring	3	Copenhagen
S	liner	4	Ohio
		5	Bombay
		6	Chandigarh

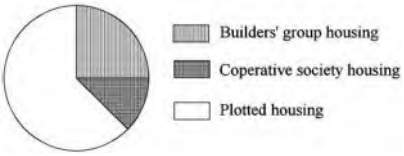
(A) P-3 , Q-2 , R-4 , S-6 (B) P-2 , Q-3, R-1 , S-5 (C) P-1 , Q-2 , R-3 , S-6 (D) P-4 , Q-1 , R-2 , S-3

Q.75 Four sequences of development are given below. Choose the one that is appropriate for slums
(A) land -> services -> house -> people (B) land- > services -> people -> house
(C) people -> land -> house -> services (D) land -> people -> house -> services

(A) 90-120 meters (B) 50-80 meters (C) 120 – 150 meters (D) 150 – 300 meters

2.6 What is the rate of ventilation due to wind action if the free area of the window is 1 sq.m., and the wind speed is 1 m/hr. Assume the wind to be perpendicular to the window.
(A) 1.0 cu.m./hour (B) 0.6 cu.m./hour (C) 0.3 cu.m./hour (D) 0.1 cu.m./hour

2.7 The diagram below shows the relative distribution of different types of housing within a total residential area of 150 hectares. If the net density of the plotted housing area is 350 ppha., how many people will be accommodated there?
(A) 20,000-25,000 (B) 25,000-30,000
(C) 30,000-35,000 (D) 35,000-40,000



2.8 As per 1991 Census, the urban component of India's total population was between
(A) 10% and 20% (B) 20% and 30% (C) 30% and 40% (D) 40% and 50%

2.9 Zinc coating is given over the steel reinforcement to
(A) increase tensile strength (B) reduce bending capacity (C) reduce corrosion (D) increase bind strength

2.10 Which of the following sequence of names constitutes the botanical name for identification and use of landscape plants? (A) species and order (B) order and species (C) family and species D) genera and species

2.11 For a four-way road intersection the following alternative traffic management schemes are proposed.
i) signalised intersection
ii) manually controlled intersection
iii) rotary intersection
Considering the above alternatives, which of the following statements is INCORRECT?
(A) All are equally space consuming
(B) (i) is more power consuming than (ii) and (iii)
(C) (ii) is more manpower consuming than (i) and (iii)
(D) (iii) is less power and manpower consuming than 'i' and 'ii'

2.12. A residential plot of 20 metre frontage and 25 metre depth is governed by the development regulations of maximum FAR of 200 and maximum plot coverage of 50%. Up to what maximum height can the plot be built?
(A) 2 floors (B) 3 floors (C) 4 floors (D) 10 floors

2.13 Minimum visibility distance at a major road intersection, for a design speed of 80 kmph is
(A) 200 metres (B) 180 metres (C) 80 metres (D) 100 metres

2.14 For accumulation of Re. 1/- for 'n' years at a given rate of compound interest 'i', the annual sinking fund is equal to (A) 1/i (B) $(1+i)^n$ (C) $\{ (1+i)^n - 1\} / i$ (D) $i / \{(1+i)^n - 1\}$

2.15 Which of the following parametric condition will provide the most suitable land for intensive development of settlement?
(A) slope = 4%; soil = silty loam aggregate; depth of water table = 6 metres; vegetation = moderate
(B) slope = 20%; soil = aggregate sand; depth of water table = 30 metres; vegetation = barren.
(C) slope = 2 %; soil = clay; depth of water table = 1 metre
(D) slope = 10%; soil = sandy loam; depth of water table = 15 metres; vegetation = dense

2.16. A rectangular room (internal dimension 5 m x 3 m) is made of 250 mm walls. Calculate the volume of concrete needed for 25 mm Damp Proof Course.
(A) 0.425 cu.m. (B) 4.25 cu.m. (C) 0.4 cu.m. (D) 4.0 cu.m.

6. Illustrate with sketches distance relationship during Greek period highlighting the major features.

7. A housing project is initiated to build 30,000 dwelling units of different categories (20% H.I.G of 80 sq.m., 30% M.I.G. of 60 sq.m., and 50% E.W.S. of 25 sq.m.). Assuming the cost of land, site development, construction cost and overhead cost to be Rs. 1,000 per sq.m., Rs. 500 per sq.m., Rs. 3,000 per sq.m. respectively for the upper income group. The total cost of the self financing project is estimated as Rs. 62,250 lacs.Work out the various cost components for E.W.S. housing.

8. Write an interactive programme in FORTRAN or BASIC for computation of V, where
$V= \sum_i^n (x_i y_j)$

SECTION B (50 marks)
PART 1 Answer any TEN questions. All questions carry equal marks.

9. Explain important architectural contributions made by Mies Van der Rohe in his dometic buildings.

10. Explain with sketches construction of Gothic wall and vaults.

11. Illustrate with sketches the difference between random rubble and ashlar works in stone masonry.

12. Draw a conceptual diagram and label the different components of the typical fire-fighting system in an apartment building above 24 m.

13. An investor has a capital of Rs. 15 lacs from which he expects a return of 14.5%. He intends to purchase a small workshop from whichthe net annual income is expected to be Rs. 5 lacs. Calculate the maximum price which the investor can invest for the workshop if money can be borrowed in mortgage at 16% interest for 8 years.

14. Draw a sun-path diagram labelling all the elements in it for any topic. What information does the sun-path diagram convey to an architect?

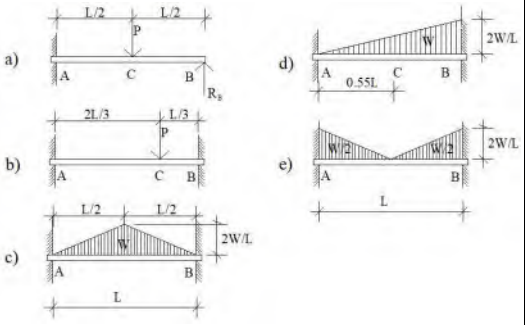
15. Explain salient architectural features as evident in Qutub Minar.

16. Distinguish between 'setting of cement' and 'hardening of cement'.

17. What is meant by 'Occult Balance' ? Illustrate occult balance through a sketch within a frame of 10 cm x 10 cm.

18. Highlight the principles of Jain temple planning.

19. Draw the Bending Moment and Shear Force diagram for the following:



20. Critically compare between two known network analysis techniques 'PERT' and 'CPM' with respect to architectural projects.

21. Design and illustrate a general classroom for 40 students in hot-humid climate, and mention the design criteria adopted.
22. Outline the usefulness of Building Bye-laws.

23. Highlight the importance of GIS in the planning decision making.

24. Analyse 'St. Mark's Square, Venice' from the urban design point of view, highlighting the merits and achievements.

25. The distance between two points in a map on 1:100,000 is 2 cm. Distance between the same two points in an aerial photograph is 10 cm. The camera of the aerial photograph was flown with a focal length of 6 inches. Find out the scale of the photograph and calculate the flying height.

26. Highlight the Demographic characteristics for delineation of a Region.

27. Illustrate with sketches the major features of Mohenjodaro Plan.

28. A property has been sold by the Housing Board on a conditional sale. The Board is to receive Rs. 24,000 at the end of every year for 10 years, and further, the Board is to receive Rs. 200,000 at the end of 10 years. A period of 4 years has already lapsed. Estimate the current value of the property (Interest rate for Years Purchase is 8%)

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iv. Land use and Land cover
v. Grey value contrast and Colour contrast

SUBSECTION A2 (Total 25 marks, 5 marks each)

6. Write a simple interactive programme in BASIC or FORTRAN to compute the volume of a regular cone.

7. State, to the point, the environmental attributes of trees in urban planning context.

8. Mention basic patterns of city forms and illustrate them with diagrammatic sketches.

9. State the effects of pollution on microclimate in an industrialised urban area.

10. Compute the capacity and workout the dimension of a septic tank for a small colony of 500 persons with average daily sewage flow of 75 litres per head. Detention period is 36 hours. Cleaning interval is six months. Assume rate of deposited sludge as 25 litres per capita per year.

SECTION B (50 marks)
PART I (Answer any 10 questions. All carry equal marks)

11. What are the influencing factors for the development of regional style in Indo-Islamic architecture.

12. Discuss, to the point, the contributions made by Le Corbusier in Modern Architecture.

13. Explain and illustrate with sketches the principal differences between Greek Agora and Roman Forum in terms of planning and architectural features.

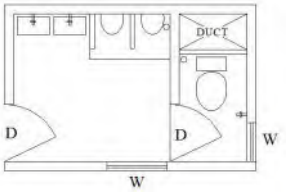
14. 'The sense of urban spatial scale is based on enclosure'. What are the different degrees of enclosures and how do they help in perception of urban spaces and forms?

15. In five square frames of equal size, make compositions using lines and square shapes depicting (i) rhythm (ii) pattern (iii) bi-axial symmetry (iv) spatial depth and distance and (v) rotation.

16. Compute the thermal transmittance (U) value for a 230 mm brick wall with 12.5 mm thick cement plaster on both sides (value of thermal conductivity for brick wall and cement plaster are 69 and 80 respectively in K cal cm/ m^2h deg C. Thermal conductance of outside and inside walls are 0.05 and 0.16 respectively.)

17. Draw two consecutive layers of (i) octagonal brick pier and (ii) rat-trap bond at right-angled corner brick wall.

18. Draw and label an isometric single-line diagram of a plumbing system for a first floor toilet (shown below)



19. A newly built property fetches an annual rent of Rs. 18,00. As per agreement tenant is liable to pay out-going equivalent to 18% of the annual rent. Calculate the present value of the property. (Assume rate of interest as 8.5%)

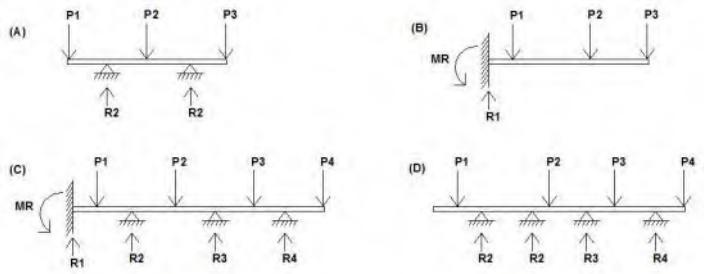
20. Highlight briefly the features of a typical Japanese garden.

21. a) what are the controls essential for comfort air conditioning in India? Mention the ranges of each control element.
b) Why is dehumidification essential in summer air conditioning?

22. Why is artificial lighting preferred to natural lighting in a museum or art-gallery?

23. Mention the common acoustical defects encountered in the design of a big auditorium. Mention their causes.

24. Determine which of the following are determinate or indeterminate structures.



25. A reinforced concrete slab (having balanced section) has an overall depth of 100 mm. The effective cover is 20mm. If the stresses in concrete and steel are not to exceed 5N.mm2 and 140N/mm2. Find the safe uniformly distributed load which can be placed on the slab. The slab is supported on beams at 3.0m c/c on both sides. The maximum bending moment for a meter strip of slab may be taken as Wl2/12. Take the moment of resistance of the balanced section as equal to 0.85 bd^2Nmm.

26. The time estimate of various activities of a project in the following Table. Determine the standard deviation of the critical path.

Activity	Optimistic Time (Weeks)	Most Likely Time (Weeks)	Pessimistic Time (Weeks)
1-2	8	12	22
1-3	6	12	18
2-4	1	4	7
3-4	5	9.5	11
2-5	9	15	21
4-5	3	4	5

27. What are hue, value and intensity in a colour scale? Indicate their position in a three dimensional diagram.

28. Mention the factors that made the architecture and planning of Fatehpur-Sikri unique.

29. Mention the means of controlling external noise which should be considered while de-signing a building.

30. State the function of DXFOUT, DXBIN and XREF commands in AutoCAD.

SECTION B (50 Marks)
PART II (Answer any TEN questions. All carry equal marks)

11. A main sewer is to be designed to receive a flow from 2 sq. Km. Area of a community, where the population density is 250 persons/hectare. The average sewage flow is 120 litres per capita per day. What will be the design flow of the main sewer? Assume peak factor as 3.

12. Sketch and label a common Rotary Intersection. State the advantages and disadvantages of Rotary Intersection.

13. Explain the concept of zero-base budgeting in urban development.

14. Outline the basic elements which constitute the mental image of a city.

15. What is meant by Land Pooling Technique in urban Land Management? Discuss the operational steps for preparing a Land Pooling scheme.

16. Discuss the role of co-operative having in mitigating the housing shortage in India. Mention the merits of co-operative housing.

17. Mention the factors that govern the determination of most appropriate housing density for a particular area. Enumerate each of them briefly.

18. Discuss the applicability of Scalogram Analysis in spatial development planning.

19. Distinguish between 'Multi-objective' and 'Multi-criteria' models for decision and evaluation of planning projects. Mention at least three techniques for each category.

20. a) Explain the concept of relief displacement on aerial photography.
b) A flat area is photographed in a scale of 1:10,000 with a camera of 15 cm focal length. The bottom of a chimney stack is found to lie at a distance of 12.01 cm from the principle point of the photograph and the top at a distance of 12.22 cm. Find the height of the chimney stack.

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

22. State briefly the various Site Analysis Techniques for appropriate decision making in urban landscape projects.

23. Highlight the principles of 'Ekistics' and illustrate graphically.

24. Mention the importance of Environmental Impact Assessment in handling large projects. State various methods for identifying environmental effects and impacts.

25. State the objectives of subdividing a planning area into traffic zones.

26. Mention the different shapes suggested by Manasara for town and villages in ancient India. Sketch at least four such shapes.

27. State the objectives of Sites and Services Scheme. Mention it's advantages and limitations in Indian Context.

28. What is meant by 'Decibel Zoning'? Mention principal types of urban noises and the planning measures to control them.

29. a) Differentiate between 'Mohallas' of traditional cities and 'Neighbourhood units' in modern cities.
b) Explain the difference between 'housing need' and 'housing demand'.

30. Illustrate with sketches the important planning features for any ONE of the following cities.
1) Brasilia 2) Islamabad

END OF THE QUESTION PAPER GATE 1996

42. Complementary color of Red is?
(A) Green (B) Blue (C) Yellow (D) Cyan

43. Concentric Zone theory was proposed by?
(A) E. W. Burgess (B) E. L. Ullman (C) P. Mann (D) C. D. Harris

44. 'Conurbation' was coined by?
(A) Walter Christaller (B) Patrick Geddes (C) Paul Davidoff (D) Homer Hoyt

45. RADBURN is an example of?
(A) Motor Age Town (B) Garden City (C) City Beautiful Movement (D) Grid Iron Pattern

46. The concept of place, work, folk was proposed by
(A) Ebenezer Howards (B) Patrick Geddes (C) Patrick Abercrombie (D) Christopher Alexander

47. The road network system prevalent in Chandigarh is called
(A) V3 Road System (B) V5 Road System (C) V9 Road System (D) V7 Road System

48. When was first attempt made to converse and protect human environment made in Stockholm Declaration?
(A) 1970 (B) 1972 (C) 1974 (D) 1975

49. Match the following.

Group I		Group II	
1.		A.	Edward Durrel Stone
2.		B.	Raj Rewal
3.		C.	Uttam C. Jain
4.		D.	Joseph Paxton

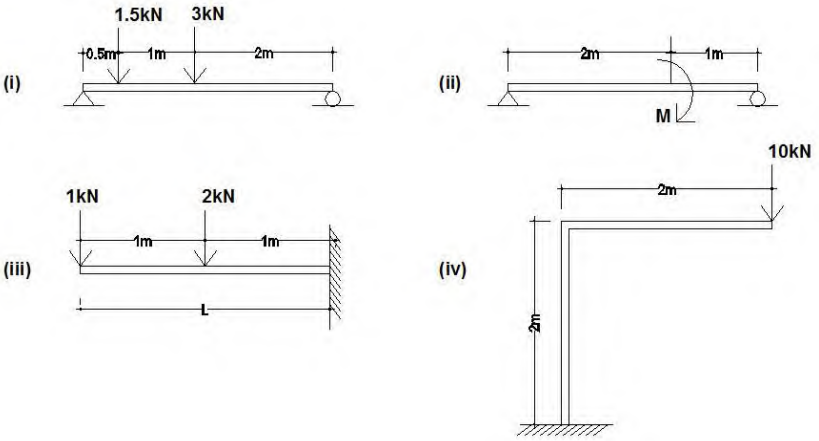
10. Following information about income pattern is available from household survey of a community.

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

10.1 Find out percentage of families earning a monthly income above Rs 1,500.

10.2 Draw a pi-diagram showing percentage distribution of various income groups.

11. Draw the bending moment and shear force diagram for the following:



12 List six factors that are considered while selecting a tree for a landscape.

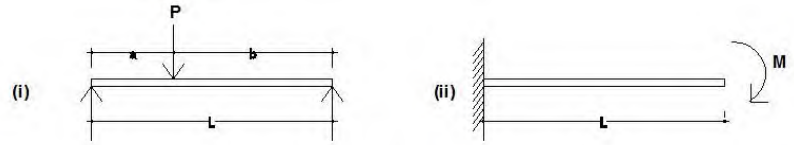
13 Draw the CPM network and determine the critical path from the following data:

SN	Activity	Duration (days)	Preceding activity
1	A	4	-
2	B	10	-
3	C	6	-
4	D	6	A
5	E	8	B
6	F	3	C
7	G	7	D
8	H	2	E

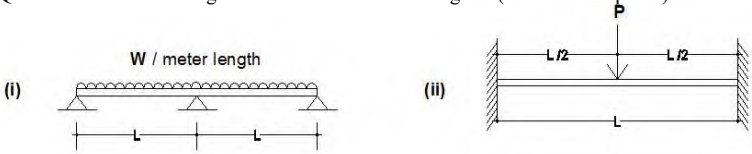
14. Find the errors in the following FORTRAN program: (Out of syllabus now!)

15 Draw a sketch of a typical Greek Temple facade and name the important elements.

END OF THE QUESTION PAPER GATE 1992



Q11.2 Sketch the bending moment and shear force diagram (values not required) :



Q.12 Explain the following planting techniques:
12.1 Grafting 12.2 Layering 12.3 Cutting 12.4 Transplantation

Q.13 Draw the CPM network diagram with the activities as shown below:

S.N.	Activity	Preceding activity
1	A	-
2	B	A
3	C	A
4	D	C
5	E	B
6	F	E
7	G	D

Q14. Find the errors in the following FORTRAN program: (Out of syllabus now!)

Q.15 Illustrate with sketches the optical correction in Architecture developed by the Greek.

END OF THE QUESTION PAPER GATE 1991

QUESTION BANK

YEARS 2019 to 2015

Answer & Essential Notes

PART 3

By
Faculty of Architecture

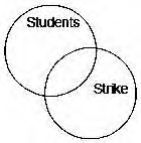
Printed in colour
for better recall in exam

GATE ARCHITECTURE

gatearchitecture.com

Q.1 Answer: **(C) to whom**
If you have to choose only one option from "whom the river victims owed their lives" and "to whom the river victims owed their lives", go with "to whom the river victims owed their lives". This version of the relative clause is undeniably grammatical in standard written English. Putting a prepositional phrase containing a *wh*-word at the front of a relative clause is called "pied-piping" by linguists; it is relatively formal and may sound stilted in conversational English, but it wouldn't be considered "incorrect" in the context of an examination that is testing your mastery of standard written English.
There is less clarity about the status of clauses like "whom the river victims owed their lives". In this relative clause, the word "whom" represents the "indirect object" of the verb *owe*. Some sources say that *wh*-fronting of indirect objects is ungrammatical, or at least "infelicitous". Different speakers seem to have different judgements of the acceptability of clauses with fronted *wh*-words functioning as indirect objects.
Source: https://english.stackexchange.com/questions/484353/should-this-relative-clause-start-with-whom-or-to-whom

Q.2 Answer: **(C) 4**
Given Statements: "Some students were not involved in the strike"
Venn diagram: >>



Only conclusion 4 is logically acceptable.
Hence, option (c) is correct.

Q.3 Answer: **(C) 33.1**
Solution: We know for volume of a (right circular) cone is $\frac{1}{3}\pi r^2 h$
Origial volume (V_o)
$(V_o) = \frac{1}{3}\pi r_1^2 h_1$
Now we know radius and height both are increased by 10%. So, after increase, the new volume will be:
$(V_n) = \frac{1}{3}\pi(1.1r_1)^2(1.1)h_1 = 1.331*(\frac{1}{3}\pi r_1^2 h_1) = 1.331 *(V_o)$
% change in volume = $\frac{Vn-Vo}{Vo}$ x 100% = $\frac{1.331Vo-Vo}{Vo}$ x 100% = 33.1% Answer

Q.4 Answer: **(C) 7**
Solution: According to given data, the only possible arrangement is:
10 5 4 7 2
So, second from right will be 7.

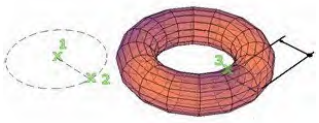
Q.5 Answer: **(A) defeated**
Explanation: If two events occur in past one after another, the event completing first, takes place perfect tense. And another event is expressed in simple past tense.

Q.6 Answer: **(C)**
Explanation: The argument says that banking institutions had been demanding for a reduction in interest for the last one year. Finally the government decided to reduce the interest rates of small saving schemes thus implying that the government does consider the demands of banking institutions before making any such policy decision.

Q.7 Answer: **(A) 10.50**
Solution: Total population = 1400 million
Number of people who having own mobile phones
= 70% of 1400 = 0.7 x 1400 = 980 million

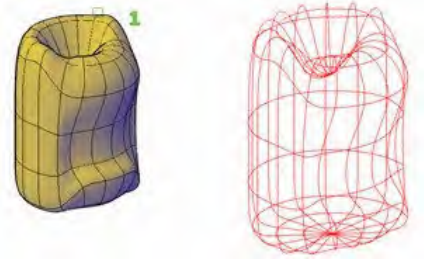
Number of people who have access of internet = 294 million
Number of people who buy goods from e-commercial portals = half of interest users
= $\frac{294}{2}$ = 147 million
Percentage buyers = $\frac{147\ million}{1400\ million}$ x 100% = 10.5%

Q.8 Answer: **(C) *baaj*, institution**
Explanation: Following are the correct pairing:
Dhrupad style - *baani*
Gayaki - vocal style
Baaj – instrumental style
Gharana – musician from a particular lineage

 **Torus:** Creates a 3D mesh primitive torus. We need to specify two values: the size of the tube and the distance from the center of the torus to the center of the tube.		

XEDGES (Command): Creates wireframe geometry from the edges of a 3D solid, surface, mesh, region, or subobject. With the XEDGES command, you can create wireframe geometry by extracting all the edges from the following objects:

- 3D solids
- 3D solid history subobjects
- Meshes
- Regions
- Surfaces
- Subobjects (edges and faces)



Press and hold Ctrl to select faces, edges and component objects, repeating if necessary. Objects such as lines, arcs, splines, or 3D polylines are created along the edges of the selected objects or subobjects.

PFACE (Command): Creates a 3D polyface mesh, vertex by vertex.
(Source: https://knowledge.autodesk.com)

Q.12 Answer: **(C) Adolf Loos**
Notes: **Ornament and Crime**

After re-establishing himself in Austria, Loos railed against the trend of Art Nouveau which was popular in Austria. Loos saw the use of intricate designs in Art Nouveau as childish and immature and claimed that the march of progress in history was toward a time when ornament was no longer a part of design. Loos believed that humans would evolve to be able to appreciate architecture and utensils for their intrinsic beauty as functional objects. Remembering the work and value of his father's time as a stone mason, Loos argued to Austria and the world that the inclusion of needless decoration was a waste of money by the designers, and a waste of time by the builders (and therefore criminal). Instead, he proposed that society should embrace forms which existed to serve a function, as was the case with the industrial buildings Loos saw during his time in America.
In 1908, Loos published his landmark essay 'Ornament and Crime' where he made a moral case for architecture to abandon ornamentation. Loos argued that it was not just preferences or taste that drove people to prefer

Figure: Adolf Loos

Figure: Café Museum. The structure was built so that the exterior was entirely a result of the function of the building, and Loos used materials to give the structure its color rather than adding decorative coats of paint. The beauty of the building comes entirely from the use of the various materials Loos incorporated into its function. Loos worked to make the luxury of the piece flow entirely from the beauty of the materials and the visual appeal of its utility.

style in their structures, but that this preference also imposed harsh social costs on those in other classes who were occupied with the work to make a design which served only to entertain, which Loos found childish. From his writings, we can see the origin and justification for the mantra of modern architecture that 'form follows function'.

Scan to read the whole essay here. (Although out of syllabus!)

https://faculty.risd.edu/bcampbel/Loos-Ornament%20and%20Crime.pdf

Essay Source: https://www.archdaily.com/798529/the-longish-read-ornament-and-crime-adolf-loos
Source: https://study.com/academy/lesson/adolf-loos-biography-architecture-buildings.html

Q.13 A sanitary landfill is provided with High Density Poly Ethylene (HDPE) lining along the ground surface. This is provided primarily to prevent **(B) Leaching**
Notes: A **landfill liner**, or **composite liner**, is intended to be a low permeable barrier, which is laid down under engineered landfill sites. Until it deteriorates, the liner retards migration of leachate, and its toxic constituents, into underlying aquifers or nearby rivers, causing spoliation of the local water.
Modern landfills generally require a layer of compacted clay with a minimum required thickness and a maximum allowable hydraulic conductivity, overlaid by a High Density Poly Ethylene (HDPE) geomembrane.

Figure: Land cover with High Density Poly Ethylene (HDPE)

The acclaim for High Density Polyethylene (HDPE) is essentially due to its low initial material cost and excellent chemical resistance. This permits thicker sections to be used compared to other geomembrane materials. A thick, durable, HDPE liner can be placed in exposed applications where the price of other materials would be prohibitory.
Legislations in several nations around the planet have driven the market for landfill liners making waste containment the single biggest use for HDPE liners.

(Source: Wikipedia.org , https://atlanticliningcompany.com/recent-projects-2/ https://blog.landfillcqa.co.uk/hdpe-landfill-liners.html)

Q.17 The spherical surface of the geodesic dome comprises of **(C) Equilateral triangles of uniform size**

The Geodesic Dome was invented by Buckminster Fuller in the late 1940s. It was designed as an efficient building structure that addressed many of the housing issues related to traditional buildings. The geodesic dome is considered to be a very efficient means of enclosing space. Fuller's invention went relatively unnoticed in 1951 when he began to apply for patents. Recently, however, standardized designs and manufacturing techniques have led to an increase in the number of "dome kits" that are offered by a variety of manufacturers and distributors. There are close to 50,000 geodesic domes in existence today.

Figure: Buckminster Fuller

A geodesic dome consists of a network of triangles that are joined together to create a roughly spherical surface. If a sufficiently large number of triangles are used, the geodesic dome approximates a true sphere. Furthermore, different sized triangles allow the geodesic dome to be divided symmetrically by 31 different great circles. A great circle is the largest circle that can be drawn around a sphere. On Earth, for example, the equator represents the only latitude line that is a great circle. On the other hand, all longitude lines are great circles. Because of these properties of symmetry, geodesic domes get their name from the Latin word geodesic, meaning "Earth-dividing".

The benefits of a geodesic dome structure can be realized by examining the properties of a sphere. For example, a sphere represents a shape that has the highest volume to surface area ratio. This means that material costs can be minimized without sacrificing interior space. Furthermore, a half-sphere (the shape used for most residential domes) allows for a maximum amount of floor space for a given surface area. Compared with a traditional 1500 square foot home, a 1500 square foot geodesic structure (with a 23-foot high ceiling) uses almost 20% less building materials. Since they have less surface area, geodesic domes are able to reduce heating costs by as much as 50% when compared with traditional buildings. Because the spherical shape also tends to absorb the most external light, additional energy savings can be realized by reducing the need for artificial lighting.

Figure: Expo 67 in Montreal, Quebec, Canada. The museum's geodesic dome was designed by Buckminster Fuller. Photo credit - aquigabo! https://www.flickr.com/photos/138047837@N02/24356393675/sizes/l

Geodesic domes are extremely stable structures. This is partly due to the fact the triangles, which are naturally stable polygons, are used throughout. This is one of the reasons triangles are so popular in homes, buildings, and bridges. In a geodesic dome, these triangles eliminate the need to include load-bearing walls without sacrificing stability. In addition, its curved surface offers a natural layer of protection from high winds and other environmental stresses. Geodesic domes have been used in such places as Antarctica where wind speeds can reach 200 miles per hour. Bucky Fuller built many domes using geodesic principles, including a 250-foot diameter dome for the 1967 World's Fair in Montreal, Canada.

Figure: The sphere would remain open to the public for nine years until an accident involving some routine welding maintenance caused the acrylic covering to catch fire, engulfing the entire sphere in a spectacular ball of fire with flames that burned for 30 minutes. When the flames subsided, there was no sign of the acrylic walls to be seen, but the steel trusses of the dome remained. After the fire, the dome was closed to the public for over fifteen years. (*Photo credit - collectionscanada*)

Q.18 The abrupt change or junction between two ecological zones is termed as **(D) Ecotone**

An ecotone acts as the boundary or barrier between two biomes. It is the area where two distinct types of environments merge and blend.
Ecotones could be the border where forestland and grassland meet or the boundary where wetlands meet prairie. Many things form a sharp boundary such as natural formations. The area where the land meets water such as where the mangrove fields meet the ocean is also considered an ecotone. The estuary between freshwater and saltwater is also a natural ecotone.
An ecotone can be a narrow or wide area of the ecostyem. It is considered a zone of tension.
The word 'ecotone' was derived from the word ecology and the Greek word tonos, which means tension.The ecotone often shares many of the animal and plant species that both areas contain but it is also unique because it is the blending of two distinct areas.
Plants and trees tend to live along an ecotone and stretch as far into the other area as possible but because of the transition the plants or trees cannot survive past the ecotone.

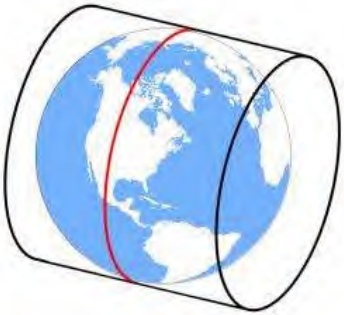
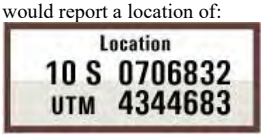
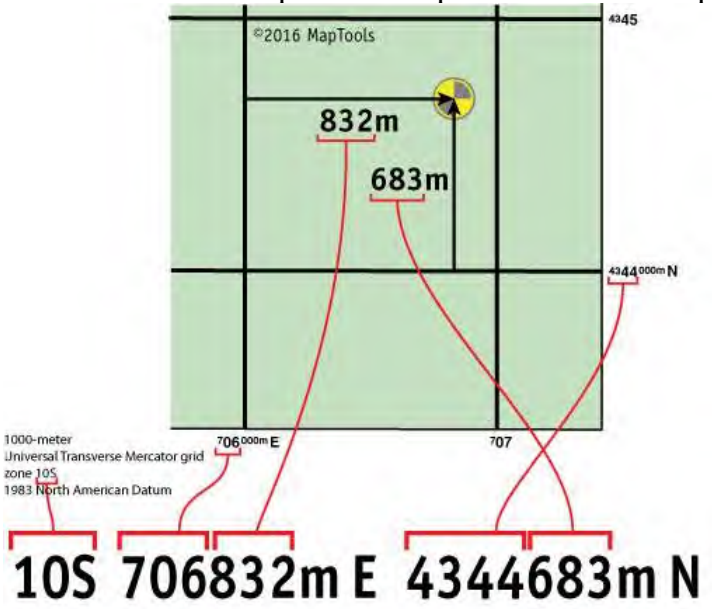


*Figure: The Universal Transverse Mercator places this cylinder **60 times for each UTM zone**.*
This means that all 60 wedges are flattened out with a transverse cylinder. Each time it's slightly rotated using a different meridian as a central line.

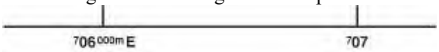
A Quick Guide to Using UTM Coordinates
Standing at the center of the marker shown on the map below, a GPS unit set to display position in UTM/UPS format, would report a location of:



Let's look at where the various parts of the UTM position come from on the map.



The map has grid lines spaced every kilometer or 1000 meters. The grid is labeled with UTM coordinate values. The vertical grid lines determine East-West position and the horizontal grid lines determine North-South position.
Look along the bottom edge of the map at the labels for the vertical grid lines.



The label, $^{706\,000m}E$, reads "seven hundred and six thousand meters East." The label, ^{707}, is an abbreviation for, $^{707\,000m}E$
The two grid lines are 1000 meters apart. The horizontal grid lines are labeled in a similar manner.
The **10S** is the Grid Zone Designation you are in. The Grid Zone is necessary to make the coordinates unique over the entire globe.

means of the historical open space of the Oval Maidan. As recommended by the World Heritage Committee, the heritage precinct is set to be renamed as 'Victorian Gothic and Art Deco Ensembles of Mumbai' shortly.

Figure: Chhatrapati Shivaji Maharaj Terminus, Mumbai

Figure: Bombay High Court building in Mumbai, India

6. Promotes CEC in soil. What is CEC is hear you ask? This is the Cation Exchange Capacity of soil particles. Cation are plant nutrients, example would be NH4+, K+, Ca2+, Fe2+ (in order thats: Ammonia, Potassium, Calcium, Iron). These are essential for plant growth and would exist in all soils. Vermiculite can hold these cations and release them into the soil as plants require them. This is the cation exchange capacity and this is an important process in soils
7. On a more basic note vermiculite can be used as a mulch or dressing for plant pots to retain moisture and maintain tempertaure of soil

Source: https://www.howtogarden.ie/use-vermiculite-growing-mediums/

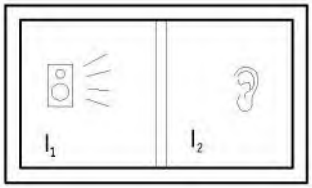
Q.30 **Building occupancy duration** is essential to estimate the Envelope Performance Factor (EPF) of a building as per the Energy Conservation Building Code (ECBC), 2011.

Q.31 Illumination, E = 300 lux = 300 lumen/sqm
Efficacy = 60 lumen/watt
LPD = Illumination / Efficacy = (300 lumen/sqm) / (60 lumen/Watt) = 5 Watt/sqm Answer
Tips: Please solve this type of question with numerical value and unit attached.

Q.32 Load on column = 150 kN
Design load consisting factor of safety = 150 * 1.2 = 180 kN

Soil bearing capacity = $80kN/m^2$
Let side of the square column footing be *S*
So, area of the column = S^2
So, total load on column = $80kN/m^2 * S^2$
As per question,
$80kN/m^2 * S^2 = 180kN$
⇨ $S^2 = 2.25$
⇨ S = 1.5 m Answer.
(Official GATE answer range: 1.49 to 1.51)

Q.33 The transmission loss (TL) of the partition wall is 30 dB.



Here $I_1 = 10^{-4}$ W/m^2 and $I_2 = 10^{-7}$ W/m^2

We simply cannot subtract intensities I_1 and I_2. We have to take log value. Also the required answer is in dB.
Sound level at source side = $10 \log (10^{-4} / 10^{-12}) = 80$ dB
Sound level at receiver side = $10 \log (10^{-7} / 10^{-12}) = 50$ dB

So, transmission loss = 80 – 50 = 30dB Answer.

Q.34 Price elasticity of demand = Change in quantity / Change in demand = 8% / 10% = 0.8 Answer
(Official GATE answer range: 0.75 to 0.85)

Q.35 Ratio of height and distance for 'Threshold of enclosure' = ½
$\tan\theta = ½$
So, $\theta = 26.5°$ Answer
(Official GATE answer range: 26.0 to 30.0)

Q.36 (D) P-3, Q-4, R-2, S-1

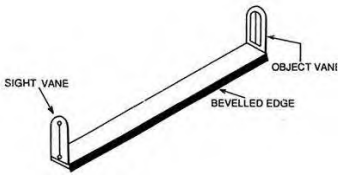


Figure: A sighting device or pointer for determining directions or measuring angles, used mainly in surveying.

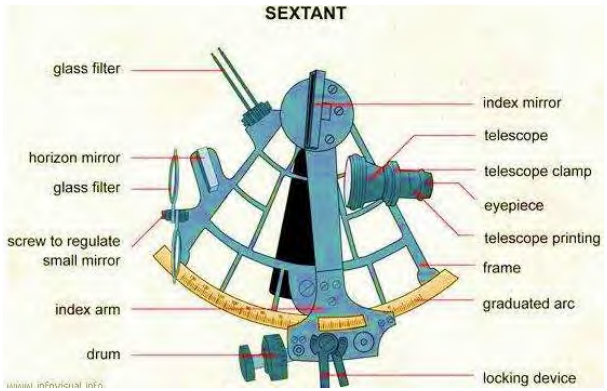


Figure: A sextant is a doubly reflecting navigation instrument used to measure altitude or the angle between any two visible objects. Sextant is one of the oldest navigation instruments used by mariners, its called sextant because its arc is 1/6th of a circle i.e. 60° but it can measure angles upto 120° using double reflection principle.

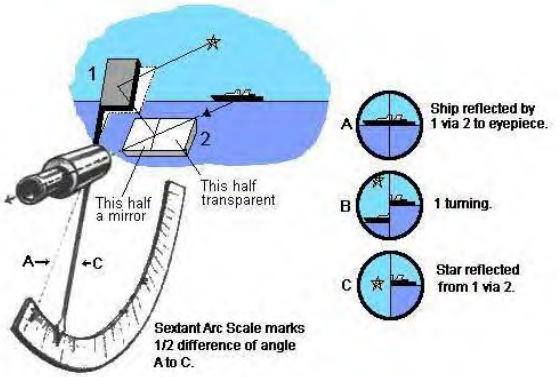


Figure: Distomat. It is a very small, compact EDM (Electronic Distance Measurement) instrument, particularly useful in building construction and other Civil Engineering works, where distance measurements are less than 500 m. It is an EDM that makes the meaning tape redundant. Through EDM, Direct measurement of distances and their directions can be obtained by using electronic instruments that rely on propagation, reflection and reception of either light waves or radio waves.

Source: http://www.clipperlight.com/howusesextant.html
http://marinegyaan.com/what-is-sextant/

The learning area is centered around the Academic Quadrangle which is composed of classrooms, faculty rooms and movement areas. One enters the campus through an entrance gate, or 'Mahadwara', which frames an ancient wooden door, and delineates a movement corridor along the auspicious north-south axis, which intersects the solar east-west axis. Along these cardinal lines the Administration, the Science centre, the Amphitheater and the Multipurpose Hall are laid out. The Catering Centre, Library and the Art Centre fall on the east-west axis, welcoming sunrises, framing sunsets and catching the daily clock of shadow movement. A number of connecting devices like ramps, seating 'ottas', 'Kund' like steps are drawn from traditional Indian settings and encourage informal meetings and interaction.

The material system is one used in the local region over the past five hundred or more years. But these old systems are used in new, innovative ways to focus on hills; sun sets and capture views. A major visual concern of the project was the integration of the geometric "construction" ensemble into vast angular geometry of the overpowering mountainous landscape. Thus, silhouettes of the stone walls were inspired by the angles of the surrounding mountains. Stone bearing walls and concrete slabs, insulated and waterproofed with tiles, were formed in a plastic manner to provide a variety of interior rooms and also to merge with the landscape. The concept of one point perspective was utilized to resolve the

Q.39 **(A) P-2, Q-3, R-1, S-5**

Design With Nature Now, presented by the University of Pennsylvania School of Design (PennDesign), will highlight dynamic and visionary approaches to landscape design and development in the face of climate change and urbanization.

Taking as its point of departure the landmark book *Design With*

Nature (1969) by Ian McHarg, the project comprises three parallel exhibitions and related programs focused on expanding the public's understanding of ecological approaches to design. A noted landscape architect and University of Pennsylvania professor, McHarg argued in his book that cities and their entire infrastructures should be

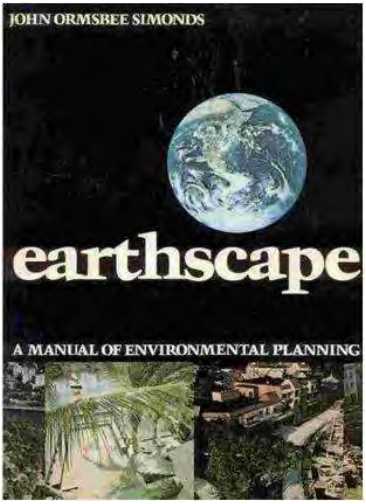


Figure: Practical information and project proposals indicate what concerned agencies, professionals, and citizens can do to establish and maintain liveable, productive, and ecologically safe and sound communities

Cordia sebastena

Plumeria alba

Q.46 **(C) P-4, Q-1, R-5, S-3**

Nahani Trap (Floor Trap)

Gully Trap

Bottle Trap

Intercepting Trap

A public space in Columbia Heights, Washington, D.C. Source: © *Chris Whitis*

New Urbanists make placemaking and public space a high priority. New Urbanist streets are designed for people—rather than just cars—and accommodate multimodal transportation including walking, bicycling, transit use, and driving. We believe in providing plazas, squares, sidewalks, cafes, and porches to host daily interaction and public life.

New Urbanism is pragmatic. Great design is not useful if it can't be built. New Urbanists work with and include production builders, small developers, traffic engineers, appraisers and financial institutions, public officials, citizens and others with influence over the built environment to come up with implementable solutions.

New Urbanism is focused on design, which is critical to the function of communities. The size and shape of a plaza will help determine whether it is consistently alive with people or windswept and vacant. The organization of buildings in a neighborhood will help establish its character. Combining appropriate design elements makes places that are greater than the sum of their parts.

New Urbanism is holistic. All scales, from the metropolitan region to the single building, are related. A building that is connected to a transit stop will help the region function better, and well-organized region benefits the buildings within it. Streets that rely only on engineering tend to move automobiles and little else; all disciplines related to the built environment must work together to create great places.

Reclaiming underutilized and neglected places is a special focus of New Urban design and building. Through the federal HOPE VI and Choice Neighborhoods programs, for example, New Urbanism has transformed deteriorating public housing into livable mixed-income neighborhoods. Commercial strips with single-use development and excessive asphalt are transformed into lively main streets or boulevards through new urban design.

Above all, New Urbanism is about creating sustainable, human-scaled places where people can live healthy and happy lives. The walkable, vibrant, beautiful places that New Urbanists build work better for businesses, local governments, and their residents. Anyone that works to create, restore, or protect a great place can join in the New Urbanism movement.

Source: https://www.cnu.org/resources/what-new-urbanism

City Beautiful movement, American urban-planning movement led by architects, landscape architects, and reformers that flourished between the 1890s and the 1920s. The idea of organized comprehensive urban planning arose in the United States from the City Beautiful movement, which claimed that design could not be separated from social issues and should encourage civic pride and engagement. Its influence was most prominent in cities such as Cleveland, Chicago, and Washington, D.C.

The movement first gained ground in 1893 with the World's Columbian Exposition in Chicago. Daniel H. Burnham headed the construction of the fair's temporary city, known to those who attended as the "White City," a semi-utopia in which visitors were meant to be shielded from poverty and crime. Burnham's plans for the site incorporated the designs of architects trained at the École des Beaux-Arts in Paris, who paired the balance and harmony of Neoclassical and Baroque architecture with the aesthetic of Chicago's buildings and cityscape. The landscape of the Columbian Exposition, which included lagoons and big green expanses, was designed by Frederick Law Olmsted, Sr., famous for his winning design of New York City's oasis, Central Park, which broke ground in 1857. To not only enhance the city's appearance but also help the flow of vehicle and pedestrian traffic, the City Beautiful concept focused on incorporating a civic centre, parks, and grand boulevards. The holistic and multipurpose approach to urban planning that was championed by Burnham and displayed at the Columbian Exposition remained at the forefront of architecture, landscape architecture, and design for many years. Its impact is still visible in many cities throughout the United States.

⇨ $\Theta = \text{Tan}^{-1}(12/5) = 67.38$ degree Answer
(GATE official answer range: 67.0 to 68.0)

Q.52 **The present value of the property using 'Valuation by Cost Method' is 91.738 Lakhs**
Present land value = Rs. 100/m^2*1 hectare = Rs. 100/m^2*100mx100m = Rs. 10 Lakh
Value of new construction = 5000 m^2 * Rs. 2500/m^2 = 125 Lakh
Depreciating rate = 6% per annum
Value after depreciation of construction in 5 years = 125 $(1-r)^n$ = 125*$(1-0.06)^5$ = 91.738 Lakh
Present value of property = 91.738 Lakh **Answer**
(GATE official answer range: 101.0 to 104.0)

Q.53 **The net residential density of the area in persons per hectare is 159.48**
Plot area = 20 Ha

Type	Area per plot (sqm)	Number	Total area (type)
A	500	100	50000
B	300	120	36000
C	200	150	30000
Total		**370**	**116000**

Population = 370 x 5 = 1850 person
Net residential density = population / net area = 1850 / 11.6 = 159.48 pph Answer
(GATE official answer range: 159 to 160)

Q.54 **The velocity of the shock wave generated is 10 km/h.**
Speed of the shock-wave = Q_2-Q_1/K_2-K_1
Q1 = Flow before Jam = 1000 V/h
Q2 = Flow after jam = 0 (because V= 0)
K1 = Density before jam = 1000 / 20 = 50 V/km
K2 = 150 Vehicle / Km (Jam density)

Therefore, Speed of the shock-wave = Q_2-Q_1/K_2-K_1 = 0-1000 / 150-50 = -10 km/h
So, the answer in absolute value is 10 km/h Answer
(GATE official answer range: 9.9 to 10.1)

Q.55 **The maximum built-up area for the residential building will be 450m^2.**
As per question, 16 mm width of road = 4m = 4000 mm
So, 1 mm = 250 mm or scale is 1:250

Therefore, actual dimension of the plot would be,
Length = 150 mm * 250 = 375000 mm = 37.5 m
Width = 40 mm * 250 = 10000 mm = 10 m

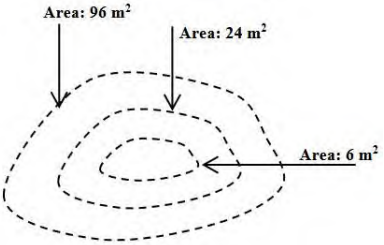
So, the area of site = 37.5*10 = 375 m^2
So built-up area = 375*FAR = 375*1.2 = 450 m^2 Answer

Q.56 **If all the doors and windows of the room are kept fully open, the reverberation time will be 0.956 seconds**
Consider the uniform absorption coefficient = a
Using, R_T = 0.16V/A
⇨ 1.2 = 0.16 * 400/360a (Total surface area of the room is 360 m^2)
⇨ 360a = 400*0.16/1.2
⇨ A = 0.148

New RT = 0.16 * 400/ (344*0.148 + 16*1) = 0.956 Answer

Note: Out of 360m^2 of room area, 344m^2 has absorption coefficient of 0.148 and rest 15m^2 area has absorption coefficient of 1 because opened door or window has absorption coefficient of 1 as it would absorb all sound)
(GATE official answer range: 0.93 to 0.97)

Q.57 **Using prismoidal method, the volume of the earth needed to fill the land depression is 66 m^3.**



Prismoidal method is used in calculation of earthwork quantities. It states that the volume of any prismoid is equal to one-sixth it's length multiplied by the sum of the two end-areas plus four times the mid-area.
So, volume of earth fill = d/3 ($A_1 + 4A_{odd} + 2A_{even} + A_n$)
Depth of depression, d = 1m
Volume of earth-fill = 1/3 (96 + 4*24 + 2*0 + 6) = 198/6 = 66
Answer

Notes: In many construction projects, earthwork involve the excavation, removal and dumping of earth, therefore it is required to make good estimate of volume of earthwork. Volume computation are also required to determine the capacity of reservoirs.

Computing of areas and volumes is an important part of the office work involved in surveying. For computation of the volume of earthwork, the sectional area of the cross-section which are taken to the longitudinal section during profile leveling are first calculated.
After calculating the cross-sectional areas, the volume of earth work is calculated by:
• *The Trapezoidal Rule*
• *The Prismoidal Rule.*

Computation of Volume:
Trapezoidal Rule
Volume (Cutting or Filling) V= d/2 [A1 + An + 2 (A2 + A3 + …….An-1)
i.e. Volume = Common Distance/2 x [First section area + Last section area + 2 (sum of areas of other sections)

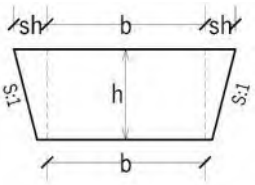
Prismoidal Formula
Volume,V= d/3* [A1 + An + 4 (A2 + A4 + An-1) + 2 (A3 + A5+ ….. An-2)]
i.e. Volume = Common Distance/3* [Area of First Section + Area of Last Section + 4 (Sum of areas of even Section) + 2 (Sum of Area of Odd Sections)]

The Prismoidal formula is applicable when there are odd number of sections. If the number of sections are even, the end section is treated separately and the area is calculated according to the trapezoidal rule. The volume of the remaining section is calculated in the usual manner by the prismoidal formula. Then both the result are added to obtain the total volume.

Prismoidal Correction
The prismoidal rule gives the correct volume directly. The trapezoidal rule does not give the correct volume. Prismoidal correction should be applied for this purpose.
This correction is always subtractive.
Prismoidal Correction for the section
$Cp = (L (h_1 – h_2)^2 * S) / 6$
Side Slope= S:1
Considering traverse Slope = 1 in n

Example: An embankment of width 10 m and side slope 1 ½ : 1 is required to be made on a ground which is level in a direction traverse to centre line. The central height at 20 m intervals are as follows:
0.8, 1.2, 2.25, 2.6, 1.9,1.4 and 0.9
Calculate the volume of earth work according to:
(1) The trapezoidal formula
(2) The prismoidal formula

Solution: Level Section : Ground is level along the traverse direction
Here, b = 10 m, s = 1.5, interval = 20 m
The cross-Sectional Area are calculated by equation: Area= (b + sh) h
$\Delta 1 = (10 + 1.5 \times 0.8) \times 0.8 = 8.96\ m^2$
$\Delta 2 = (10 + 1.5 \times 1.2) \times 1.2 = 14.16\ m^2$
$\Delta 3 = (10 + 1.5 \times 2.25) \times 2.25 = 30.09\ m^2$
$\Delta 4 = (10 + 1.5 \times 2.6) \times 2.6 = 36.14\ m^2$
$\Delta 5 = (10 + 1.5 \times 1.9) \times 1.9 = 24.42\ m^2$
$\Delta 6 = (10 + 1.5 \times 1.4) \times 1.4 = 16.94\ m^2$



$\Delta 7 = (10 + 1.5 \times 0.9) \times 0.9 = 10.22\ m^2$

Volume according to Trapezoidal Rule,
V = 20/2* [8.96 + 10.22 + 2 (14.16 + 30.09 + 36.14 + 24.42 + 16.94)]
= 10 [19.18 + 242.10]
= 2612.80 m^3
Volume according to Prismoidal Formula,
V = 20/3* [8.96 + 10.22 + 4 (14.16 + 36.14 + 16.94) + 2 (30.09 + 24.42)]
= 20 x (19.18 + 268.96 + 109.02) /3
= 2647.73 m^3

Example: Calculate the volume of earthwork in an embankment for which the Cross-Sectional areas at 20 m interval are as follows:

Distance	0	20	40	60	80	100	120
Cross-section area (m^2)	38	62	74	18	22	28	13

V= d/3 (A1 + A7 + 4 (A2 + A4 + A6) + 2 (A3 + A5)]
= 20/3* [38 + 13 + 4 (62 + 18 + 28) + 2 (74 + 22)]
= 20/3 [51 + 4 (108) + 2 (96)]
= 20/3 [51 + 432 + 192]
= 20 x 675 3
= 4500 m^3

Capacity of Reservoir: The plane containing any contour represents a horizontal plane and the area bounded by a contour is treated as the area of the cross-section. The contour interval is the vertical distance between any two adjacent crosssectional bounded by the contours. The area bounded by the contour is measured by a planimeter.
Reservoir are made for water supply, irrigation, hydropower etc. A contour map is very useful to study the possible location of a reservoir and the volume of water to be confined. All the contours are closed lines within the reservoir area.
The area A1, A2, A3,…… An between successive contour lines can be determined by a planimeter and if h is the contour interval, the capacity of the reservoir can be estimated either by the prismoidal formula or by the trapezoidal formula. In practice, the capacity of a reservoir is measured in terms of volume of water stored up to full reservoir level (FRL) which is the level of water at its full capacity.

Example: From a contour plan of a proposed reservoir area, the following data were found:

Contour (m)	100	105	110	115	120	125
Area of contour (ha)	3	8	13	17	23	29

The capacity of the reservoir if the FRL is 125 m. The volume below the contour of 100 may be ignored.

Solution: Prismoidal formula can be used when odd number of section are there So, the volume up to the contour 120 m is:
V_{120} = d/3 [(A1 + A5 + 4 (A2 + A4) + 2 (A3)] 3
= 5 [(3 + 23) + 4 (8 + 17) + 2 x 13)]
= 5/3 [26 + 100 + 26]
= 255.33 ha.m
And by trapezoidal formula, the volume, the formula, the volume between 120 and 125 m is
$V_{120\text{-}125} = h *(A_5 + A_6) / 2 = 5 \times (23 + 29) / 2 = 130$ ha.m

Total Volume, $V = V_{120} + V_{120\text{-}125} = 253.33 + 130 = 383.33$ ha.m

Volume by the trapezoidal formula:
V= h/2* [First Area + Last Area + 2 (Sum of area of other section)]
= 5/2* [3 + 29 + 2 (8 + 13 + 17 + 23)]
=5/2 * (32 +122) = 385 ha-m

Example: The area enclosed by the contour in a reservoir are as follows:

Contour (m)	175	180	185	190	195
Area (m^2)	460	750	2500	3500	3950

The top water level is 195 m and the lowest point in the reservoir is 175 m. Find the volume of water (reservoir capacity) between 175 m and 195 m by:

- Trapezoidal formula
- Prismoidal formula

Contour Interval = 5 m
Volume according to trapezoidal formula, V= h/2* [A1 + A5 + 2 (A2 + A3+ A4)] = 5/2* [460 + 3950 + 2(750 + 2500 + 3500)] = 44775 m^3
Volume according to Prismoidal formula, V= h/3 [A1 + A5 + 4 (A2 + A4) + 2 (A3)] = 5/3* [(460 + 3950) + 4 (750 + 3500) + 2 (2500)] = 5/3 [4410 + 1700 + 5000] = 44016. 66 m^3

Source: "Surveying and Leveling" Vol- I Kanetkar and Kulkarni (2011) "Surveying and Leveling" N.N.Basak
https://www.slideshare.net/gauravhtandon1/volume-28486423

(GATE official answer range: 65 to 76)

Q.58 **As per the proposal, 28.5 kWh solar power will be generated daily.**

Given data				*Data calculation*	
Orientation	No. of Panels	Average daily solar radiation in W/m2	Average solar hours per day	*Total electricity generation*	*At 75% efficiency*
South	10	400	4	*10*400W/m^2*2m^2*4hours = 32 kWh*	*0.75*32 kWh = 24kWh*
West	5	300	2	*5*300W/m^2*2m^2*2hours = 6 kWh*	*0.75*6 kWh = 4.5 kWh*

Total energy generation = 24 + 4.5 = 28.5 kWh Answer
(GATE official answer range: 28.4 to 28.6)

Q.59 **The amount of soil excavated by the power shovel per day is 720m^3.**
Total working hour = 6 hrs (given)
Time wasted = 10 minutes per hour. So, total time wasted = 10 minutes * 6 = 1 hour
Therefore, effective working hours = 5 hours = 300 minutes = 18000 seconds

As it takes 45 seconds for 1 excavation.
So, no. of excavations in 18000 seconds = 18000/45 = 400 excavations

As 1.8m^3 of soil is excavated in 1 excavation.
So, in 400 excavations, amount of soil excavated would e = 1.8m^3 * 400 = 720 m^3 Answer
(GATE official answer range: 719.75 to 720.25)

Q.60 **The capacity of the air-conditioner for the room will be 1.5 Ton.**
General formula to be used is $Q = ms\Delta T$ for energy Q required to raise the temperature by ΔT of material of mass m with specific heat of s. This formula is for solid material but equally holds good for gaseous item like air.

In this question, m will be volume of air.
Volume of air = 3* volume of room ….. *(Room volume is multiplied by 3 as there are three air changes per hour.)*
= 3* (12 x 10 x 3.5) = 1260 m^3

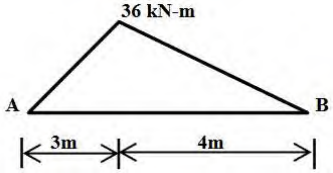
In this question, s will be 1250 J/m^3 °C and ΔT would be 12°C
Therefore, Q = msΔT = 1260 m^3 * 1250 J/m^3 °C * 12°C = 18900000 Joule and this much energy is required per hour.

So, rate of energy flow = Q/Time = 18900000 Joule / 36000 Seconds = 5250 Joule per second = 5250 Watt = 5250 W = 5.25 kW

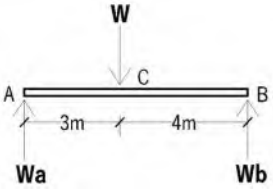
As per question, 3.5 kW = 1 Ton (given)
So, 5.25 kW = 5.25/3.5 Ton = 1.5 Ton Answer.

(GATE official answer range: 1.49 to 1.51)

Q.61 **The magnitude of the concentrated load is 21 kN.**



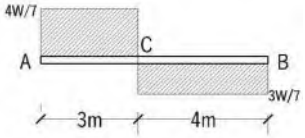
Let the concentrated load be W and the reaction force at A and B be Wa and Wb respectively.
As sum of all forces must be zero.
So, Wa + Wb = W …… (1)



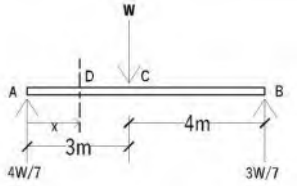
Point A:
Sum of moment at point A should be zero.
So, Wb*7 – W*3 = 0
So, Wb = 3W/7 ……..(2)

Point B:
Sum of moment at point B should be zero.
So, W*4 – Wa*7 = 0
So, Wa = 4W/7 ……..(3)

SFD (Shear Force Diagram):



Calculation of BMD (Bending Moment Diagram):

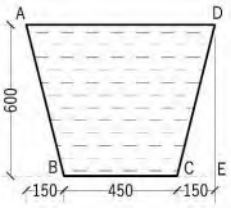


Bending moment at point D which is at a distance x from point A. $(0 \le x \le 3)$
$\sum M_x = 4W/7*x$

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

Q.62 **The velocity of flow of water is 0.45 m/sec.**
One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

Manning's Equation:



$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S}$$

Where:

Q = Flow Rate, (ft^3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft^2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Please note that in the question velocity is not the flow rate.
So, the required equation would be:

Velocity of flow = $1/n * r^{2/3} * S^{1/2}$
Here, n = 0.05
Hydraulic radius, r = wet area / wet perimeter = 0.36/1.6869 = 0.2134 m
Slope = 1/250 = 0.004
Therefore velocity = $1/0.05 * (0.2134)^{2/3} * (0.004)^{1/2}$ = 0.4517 Answer
(GATE official answer range: 0.40 to 0.50)
Source: http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Manning_s_Equation.htm

Q.63 **The motive force due to the stack pressure over a cross section area of 2.5 m^2 is 15.75 N.**
Stack effect relies on thermal forces set up by the density difference (caused by temperature differences) between the indoor and the outdoor air. It can occur simply through an open window (when the air is still); the warmer and lighter indoor air will flow out at the top, and the cooler, denser outdoor air will flow in at the bottom.

Stack effect can be used as a special provision in ventilation shafts. Higher the shaft, larger cross sectional area, greater the T, greater the motive force, the more air will be moved.

F= P * A
Stack pressure, P_s (N/m^2) = 0.042 (N/m^3degC) * h(m) * T (deg C)

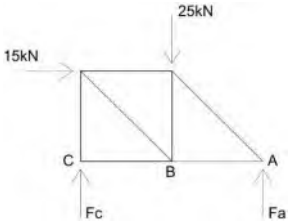
Given, h = 10m, T = 15°C, A = 2.5 m^2
So, Stack pressure = 0.042*10*15 = 6.3 N/sqm
Therefore, Force = 6.3 N/sqm*2.5 m^2 = 15.75 N Answer

This effect is utilized in multistory apartments for ventilation of the shafts of toilets, bathrooms, kitchen, etc. Stack effect occurs in tall buildings, particularly at places with vertical passages such as stairwells, elevators or shafts. The stack pressure decreases with height.

Air flow through large openings is usually bi- directional. In the general case, cold air flows in at the lower part of the opening, while warmer air flows out from the upper part. In general, the air velocity decrease and becomes zero at a height of h_n from the bottom of the opening. At that level, the so called neutral level, the pressure difference across the opening is zero.
(GATE official answer range: 15.0 to 16.0)
Source: https://www.new-learn.info/packages/clear/thermal/buildings/passive_system/passive_cooling/natural_ventilation/air_movement.html

Q.64 **The Total Fire Load of the rooms is equal to 14667 kCal/ m^2.**
Calorific value of the material is 4400 kCal/kg. Weight of combustible material is 3000 kg.
So, total fire load = 4400 kCal/kg*3000kg = 13200000 kCal
Therefore, total fire load per square meter = 13200000 kCal/ 900 m^2 = 14667 kCal/m^2 Answer
Note: Extra terms given in the question *'three rooms of area 100 m^2, 500 m^2 and 300 m^2 each'* & *'proportion of 30%, 50% and 20%'* might be to confuse the aspirants or it could be an error. This might be a reason the answer provided by GATE official was 61500 to 61700 or 14600 to 14700

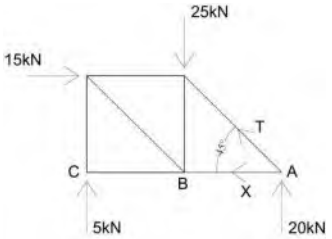
Q.65 **The force in the member AB will be 20 kN.**
Our first aim should be to calculate reaction forces at support i.e. at A & C
Let the reaction force at C be Fc and reaction force at A be Fa



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

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

Joint A:

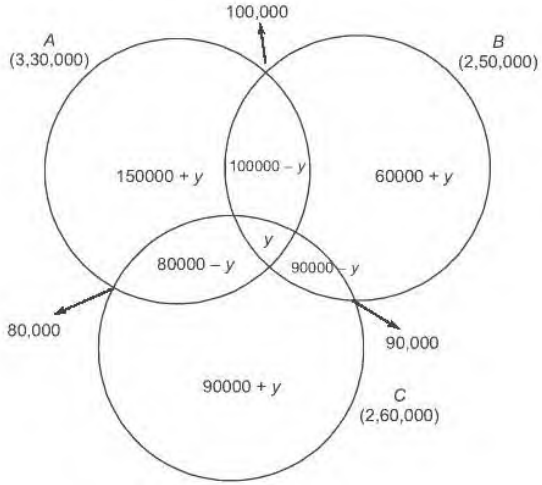


Sum of vertical forces at point A must be zero.
So, T*Sin45 + 20kN = 0
⇨ T = - 20kN/Sin45° ……(2)
Sum of horizontal force at point A must be zero.
Let the force in the member AB be X.
So, X – T*Cos45° = 0
⇨ X = 20 kN (Value of T is taken from equation (2)

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

END OF THE ANSWER PAPER GATE 2019

Q.8 4,20,000 candidates failed to clear the test.



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

⇨ 6,30,000 – 5,70,000 = 2y

⇨ y = 30,000 Answer

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

Q.9 The value of $x^4 + 1/x^4$ is 7.

$x^2 + x = 1$

$x (x +1) = 1$

$x + 1 = 1/x$

$(x-1/x) = (-1)$

Squaring the above equation,

$x^2 + 1/x^2 - 2 = (+1)$

$x^2 + 1/x^2 = 3$

Squaring above equation,

$x^4 + 1/x^4 + 2 = 9$

$x^4 + 1/x^4 =$ **7 Answer**

Q.10 Option (B) is incorrect as there is no any factor mentioned in the paragraph that could affect the crow birth rate due to uses of cracker. For the same reason options (C) and (D) are invalid. So, the correct option is (A).

Q.1 In a Colour Wheel, Red and Blue colours are Primary colours.

There are also definitions (or categories) of colors based on the color wheel. We begin with a 3-part color wheel.


Primary Colors


Secondary Colors


Tertiary Colors

Primary Colors: Red, yellow and blue

In traditional color theory (used in paint and pigments), primary colors are the 3 pigment colors that cannot be mixed or formed by any combination of other colors. All other colors are derived from these 3 hues.

Q.3 The compressive strength of M-25 concrete is 25 N/sqmm.

IS 456-2000 has designated the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40. In this designation, the letter M refers to the mix and the number to the specified 28 day cube strength of mix in N/mm^2. The mixes of grades M10, M15, M20 and M25 correspond approximately to the mix proportions (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.
So, for M25, the M stands for mix and 25 represents the characteristic strength of concrete.
The **characteristic strength** is defined as the **strength** of the **concrete** below which not more than **5%** of the test results are expected to fall. In simpler terms, if you cast 100 cubes of 15cm*15cm*15cm and test their compressive strength using compression testing machines after 28 days, then not more than 5 cubes should fail at a value lesser than 25 N/mm^2 (25 MPa).

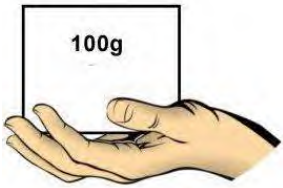


Figure: 100g in your hand is approximately equal to 1 Newton.

MPa = Mega Pascal (Mega = 10^6 & Pascal = N/m^2, So 1 MPa= 10^6 *N / m2)*
The pascal (symbol Pa) is the SI unit of pressure. It is equivalent to one newton per square metre. The unit is named after Blaise Pascal, the eminent French mathematician, physicist and philosopher.

Q.4 In Critical Path Method (CPM) for time scheduling, 'forward pass calculation' is carried out for determining (B) Early start and early finish time

Q.5 Collapse of the World Trade Center (WTC), New York, in 2001, was due to (D) Thermal performance failure of structural steel

About World Trade Center, New York: Minoru Yamasaki, the lead architect of the World Trade Center project proposed a plan that incorporated tall-standing twin towers; a design that would make these towers the tallest structures in the world at the time. Due to the height of the towers, more elevators than usual needed to be included, but this created a space problem on each floor. The concept of "sky lobbies" was introduced which were "floors where people could switch from a large-capacity express elevator to a local elevator that goes to each floor in a section." This saved a tremendous amount of space on each floor.
To make Yamasaki's design possible, the structural engineer developed a "tube" frame structural system. Such a system allowed for a more open floor plan at each level as the loads are distributed around the perimeter of the floor through the use of Vierendeel trusses.

The attack

Figure: It is estimated over 200 people jumped to their death. It took about 10 seconds to hit the ground. What was the height from where the person jumped down? g = 9.8 m/sec^2

World Trade Center tower construction

In terms of structural system the twin towers departed completely from other high-rise buildings. Conventional skyscrapers since the 19th century have been built with a skeleton of interior supporting columns that supports the structure. Exterior walls of glass steel or synthetic material do not carry any load. The Twin towers are radically different in structural design as the exterior wall is used as the load-bearing wall. (A load bearing wall supports the weight of the floors.) The only interior columns are located in the core area, which contains the elevators. The outer wall carries the building vertical loads and provides the entire resistance to wind. The wall consists of closely spaced vertical columns (21 columns 10 feet apart) tied together by horizontal spandrel beams that girdle the tower at every floor. On the inside of the structure the floor sections consist of trusses spanning from the core to the outer wall.

Bearing walls and Open floor design

When the jet liners crashed into the towers based upon knowledge of the tower construction and high-rise firefighting experience the following happened: First the plane broke through the tubular steel-bearing wall. This started the building failure. Next the exploding, disintegrating, 185-ton jet plane slid across an open office floor area and severed many of the steel interior columns in the center core area. Plane parts also crashed through the plasterboard-enclosed stairways, cutting off the exits from the upper floors. The jet collapsed the ceilings and scraped most of the spray-on fire retarding asbestos from the steel trusses. The steel truss floor supports probably started to fail quickly from the flames and the center steel supporting columns severed by plane parts heated by the flames began to buckle, sag, warp and fail. Then the top part of the tower crashed down on the lower portion of the structure. This pancake collapse triggered the entire cascading collapse of the 110-story structure.

Q.6 During the construction of tall buildings, the equipment used for hoisting building materials to the upper floors is a (D) Tower crane.

Q.7 A Rock-cut style of architecture is represented by (B) Kailasa Temple, Ellora

About **Bishnupur** (The temple town, West-Bengal): Known for its beautiful terracotta temples, Bishnupur flourished as the capital of the Malla kings from the 16th to the early 19th centuries. The architecture of these intriguing temples is a bold mix of Bengali, Islamic and Oriya (Odishan) styles. Intricately detailed facades of numerous temples play out scenes of the Hindu epics, the Ramayana and Mahabharata.

Stone has always been in short supply in the vast flood plains of Bengal. Hence the architects had to restore to other substitute. As clay was easily available the burnt clay bricks soon became a good substitute of stone. This gave rise to a new form of temple architecture and lead to the construction of elaborately decorated terracotta temples.

Terracotta literally means baked earth in Italian but West Bengal has the distinction of housing some of the finest terracotta art in the world. The terracotta art reached its pinnacle under the patronage of the Malla Kings of Bishnupur during the seventeenth century.

Temples in Bishnupur: There are more than 20 temples in a small vicinity. Few described below.

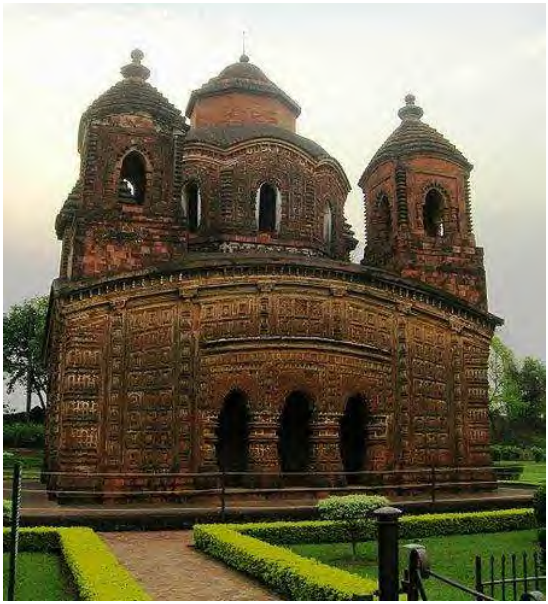


Figure: Shyamrai Temple, Bishnupur (Pancha Ratna Temple)

Shyamrai Temple: A left turn from the Ghumghar leads to the Shyamrai Temple**,** popularly known as the Pachchura temple, because of its five pinnacles. Built by Mallaraja Raghunath Singha in 1643 this is terracotta at its best.

Approached by triple arched entrance on all the four sides the Shyamrai Temple contains terracotta on all its four sides including the inner walls and the pinnacles. The Ras Chakra and love making scenes of Radha – Krishna are the most sort after terracotta panels of the Shyamrai Temple.

Rasmancha: Built in 1600 by the Malla King Hambir, the Rashmancha is the oldest standing structure of Bishnupur. Consisting of arched entrances separated by pillars the Rashmanch stands on a raised laterite stone platform and is crowned with a stepped pyramidal structure surrounded by smaller typical Bengal styled sloped roofed structures.

Figure: Ras Mancha, Bishnupur

Figure: Arial view of Kailasa Temple

YouTube

Watch on YouTube

"**Kailasa Temple in Ellora Caves - Built with Alien Technology?**"

https://tr.im/KailasaTempleMade

Scan or visit:
https://tr.im/KailashTemplePlan

Kailash Temple, Ellora

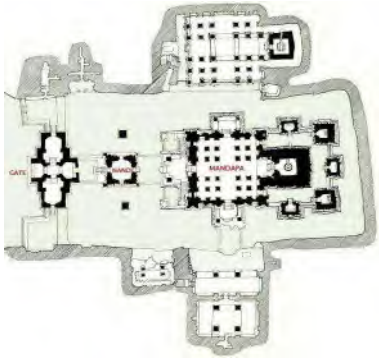


Figure: The plan of the Kailash Temple

Source:http://www.greatbuildings.com/buildings/kailasa_temple.html
https://postcard.news/why-kailash-temple-is-not-considered-as-a-wonder-of-the-world-forget-constructing-this-temple-again-it-cant-even-be-destroyed/
http://www.themysteriousindia.net/mind-boggling-images-of-the-kailasa-temple/

The **Khajuraho temples** are a pinnacle of the North Indian *Nagara* architectural style.
The *Nagara* style's primary feature is a central tower (*shikhara)* whose highest point is directly over the temple's primary deity. This is often surrounded by smaller, subsidiary towers

Figure: Kandariya Mahadev Temple, Khajuraho and details

3. **Self-employment Programme (SEP):**It focuses on providing financial assistance to individuals/groups of urban poor for setting up gainful self-employment microenterprises/ventures, suited to their skills, aptitude, training and local conditions.
4. **Capacity building and Training (CB&T):** Under NULM, a multi-pronged approach is planned for continuous capacity building of SHGs, Government functionaries at Central, state and town/city levels, NGOs and other stakeholders. National and state-level mission management units are also created to support the implementation of the mission.
5. **Support to Urban Street Vendors:** It focuses on development of vendors market, credit enablement, socio-economic survey of street vendors, skill development and microenterprises development. It also seeks to provide social assistance to urban street vendors by converging various schemes of Government.
6. **Shelter to Urban Homeless (SUH):**Under it, permanent all-weather 24 x 7 shelters equipped with essential services will be constructed.
7. **Innovative and Special Projects:** It focuses on the promotion of novel initiatives in the form of innovative projects.These novel initiatives must aim at catalysing sustainable approaches to urban livelihood through public, private, community partnership.

Integration in Deendayal Antyodaya Yojana

The Union Government has decided to integrate both National Urban Livelihoods Mission (Ministry of Housing and Urban Poverty Alleviation) and National Rural Livelihoods Mission (Ministry of Rural Development) to converge into a single scheme called Deendayal Antyodaya Yojana (DAY) in 2016-17.

Sources: https://nulm.gov.in/
https://www.gktoday.in/academy/article/national-urban-livelihoods-mission/

The '**Make in India**' program is an initiative launched to encourage companies to increase manufacturing in India. Prime Minister Narendra Modi launched the Make in India initiative on September 25, 2014, with the primary goal of making India a global manufacturing hub. This not only includes attracting overseas companies to set up shop in India, but also encouraging domestic companies to increase production within the country. 'Make in India' aims at increasing the GDP and tax revenues in the country, by producing products that meet high quality standards, and minimising the impact on the environment.

Fostering innovation, protecting intellectual property, and enhancing skill development are the other aims of the program according to the 'Make in India' website.

Policies under 'Make in India' initiative:

There are 4 major policies under the 'Make in India' program:

1. New Initiatives: This initiative is to improve the ease of doing business in India, which includes increasing the speed with which protocols are met with, and increasing transparency.

Here's what the government has already rolled out

- Environment clearances can be sought online.
- All income tax returns can be filed online.
- Validity of industrial licence is extended to three years.
- Paper registers are replaced by electronic registers by businessmen.
- Approval of the head of the department is necessary to undertake an inspection.

Foreign Direct Investment (FDI):

The government has allowed 100% FDI in all the sectors except Space(74%), Defence (49%) and News Media (26%). FDI restrictions in tea plantation has been removed, while the FDI limit in defence sector has been raised from the earlier 26% to 49% currently.

Intellectual Property Facts:

The government has decided to improve and protect the intellectual property rights of innovators and creators by upgrading infrastructure, and using state-of-the-art technology.

The main aim of intellectual property rights (IPR) is to establish a vibrant intellectual property regime in the country, according to the website.

These are the various types of IPR:

- Patent: A patent is granted to a new product in the industry.
- Design: It refers to the shape, configuration, pattern, colour of the article.
- Trade mark: A design, label, heading, sign, word, letter, number, emblem, picture, which is a representation of the goods or service.
- Geographical Indications: According to the website, it is the indication that identifies the region or the country where the goods are manufactured.

Q.31 Answer (C)

Figure: S. Maria del Fiore Cathedral, Florence, Italy : Construction begun in 1296 in the Gothic style with the design of **Arnolfo di Cambio** and completed structurally in 1436 with the dome engineered by **Filippo Brunelleschi.**

Figure: *Filippo Brunelleschi (1377-1446)*

To know more about **The Secrets of the Florentine Dome** , visit the link or scan:

Source:http://schillerinstitute.org/educ/pedagogy/2013/vereycken-dome-1.html

Q.39 Answer (A)

Buildings	Architects
Guggenheim Museum, Bilbao	Frank Gehry
The Shard, London	Renzo Piano
Commerz Bank, Frankfurt	Norman Foster
Heydar Aliyev Centre, Baku	Zaha Hadid

Figure: Infographic: The World's Most Expensive Skyscrapers

Scan or visit: https://tr.im/ShardLondon

Tallest Building in London & Europe - London Bridge Tower - the "Shard of Glass"

Q10. Completion time = [(Optimistic time) + 4*(Most likely time) + (Pessimistic time)] / 6
So, [12+ 4*14+18]/6 = 86/6 = 15 Months Answer.

Q11. The additional number of dwelling units (DU) required by 2031 is 1750.
122500-105000 =1750 Answer

Q12. Answer: (C) BIM software
BIM (*Building Information Modelling*) is an intelligent 3D *model*-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure.

Q13. The velocity of "Constricted end" is 8m/s
This question is related to water supply (fluid dynamics)
$V_1*A_1 = V_2*A_2$
That way,
$V_2 = V_1 * A_1/A_2$
$= V_1$ x (r1)^2/(r2)^2
= 2 x 4 = 8 m/s

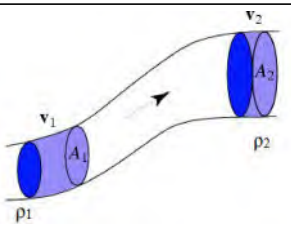


Figure: Law of continuity, $V_1*A_1 = V_2*A_2$

Q14. Contractor's fees 15% of total project cost 70k was 10500 – 20% penalty for overrun cost 2000 = 8500

Q15. (C) Super elevation is used to design speed limits at turns to ensure safety of a vehicle travelling.


Figure: **Super elevation** is tilting the roadway to help offset centripetal forces developed as the vehicle goes around a curve. Along with friction they are what keeps a vehicle from going off the **road.**

Q16. The **minimum** amount of earth to be excavated in cubic metre is 3364 m^3.
Let us, first find x.
Tan30° = x/40, x= 40*Tan30° = 40*(1/√3) = 23.09m
So, Area of triangle = 1/2*(Base)*(Height) = 0.5*40*23.09 = 461.8 square meter
So, Volume of earth = (Area of triangle)*(length of plot) = (462.42 square meter)*(30meter) = 13854cubic meter
For minimum cut, answer = 13854/4 = **3364** Answer

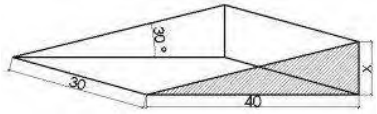


Figure: Volume = Area of triangle x 30m

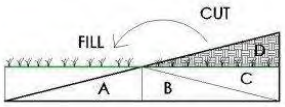


Figure: Area of triangle A = B = C = D. So, minimum cut = 13854/4

executed by the architect during the Depression, these structures employ a highly original system of cantilever-slab construction in a classic of modern office design. Frank Lloyd Wright's imaginative approach to structure is seen in his use of rounded "organic" forms, and in the T-shaped columns and "tree-like" tower.

The complex, which opened in 1939, continues to serve its original functions, and still contains original furnishings that Wright designed. Widely published, it was recognized for its importance even before it was completed, and helped the architect to gain a number of commissions.

Figure: Inside view. Johnson Wax Building by Frank Lloyd Wright. Mushroom column.

Figure: The Chrysler Building, New York designed by William Van Alen.

Figure: The Eagle. Part of the Art Deco style of Chrysler Building.

The Chrysler Building is a classic example of the Art Deco style, from

Figure: Johnson Wax Building by Frank Lloyd Wright. Mushroom column can be seen under the glass floor.

HSBC, Hong Kong

With its prefabricated steel parts, aluminium cladding, plug-in service modules and reconfigurable spaces, HSBC's office building is still one of the most modern-looking buildings around, even though it opened in 1985. The building is more akin to the structure of a bridge, with floors suspended from the distinctive chevron-shaped trusses supported by eight sets of masts that run the height of the building. The structure is not hidden and is a feature of the façade. Services are accommodated on the periphery, allowing clear floor spans.

It doesn't have a regular floor plan; floors get smaller the higher up they are in the building, and the distance they are set back from the façade to create small atria varies between floors. The lower floors rising from the public plaza on the ground level are divided into two by the banking hall atrium that runs from the front to the back of the bank. Further variation is introduced with double-height spaces on the floors that meet the bottom of each truss. Express lifts serve only certain floors; further access to individual levels is via escalators.

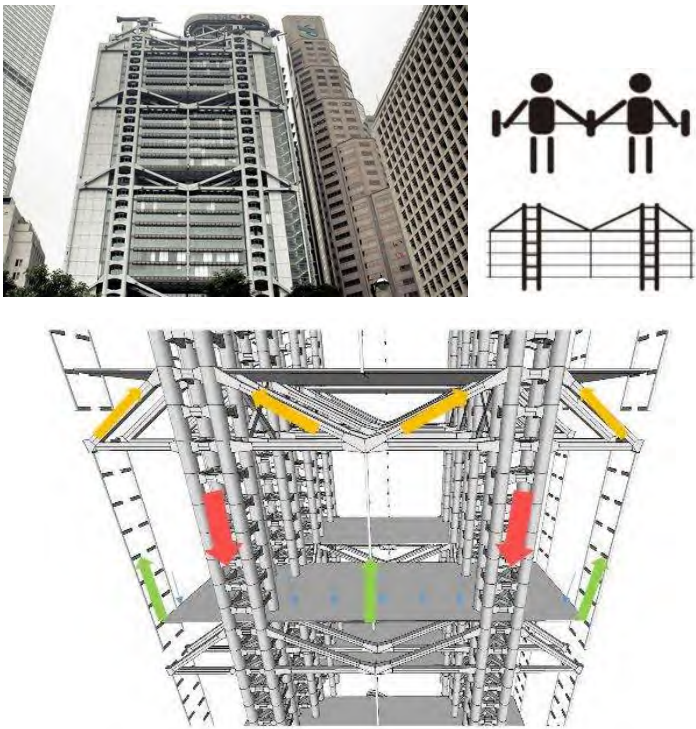


Figure: **HSBC, Hong Kong & its simplified structural system.**

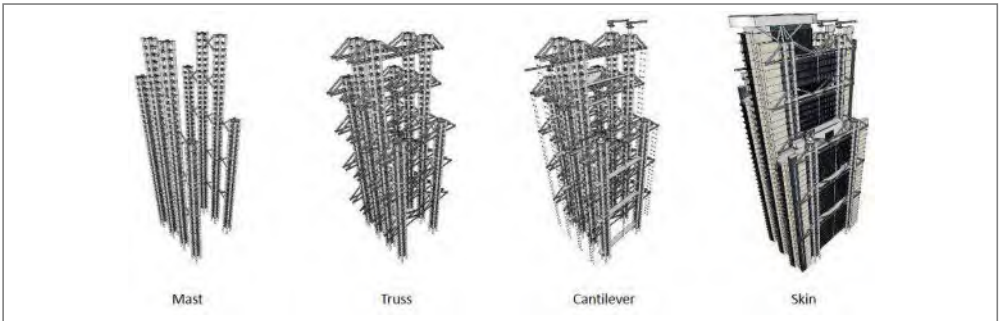


Figure: Structural system simplified.

The top of the structure is comprised of a thick glass/fibre fabric that has been coated with PTFE. It is a very durable material that is commonly used in similarly styled buildings. Due to the fact that the roof is held together using 12 struts, the building is not technically a "dome" by architectural standards. The roof was designed to actually be lighter than the air inside of the building. This helps its structural integrity significantly.

Current Use

After the failure of the Millennium Exhibition and the resulting scandal over the cost of the Millennium Dome, the dome was sold and has been rebranded as O2 Arena. It is a major exhibition and events venue in London that often hosts concerts by famous bands.

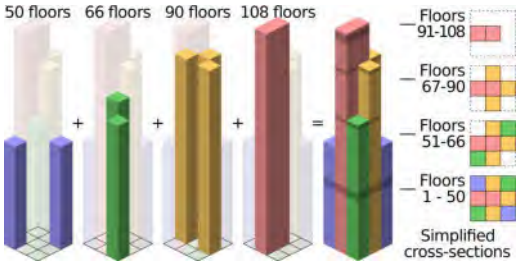


Figure: **Sears Tower, Bundled Structure**.

Sears Tower, New York (Now called Willis Tower)

As designed by architect Bruce Skidmore Owings and Merrill (SOM), the structure was a "bundled tube" system of nine squares with sides of 75 feet (for an overall 225 x 225 ft), sheathed in a curtain wall of dark tinted glass.

Figure: **Sears Tower.**

Figure: **Sears Tower, Observation Deck.**

Q52. Bending stress = 96x1000x0.1/24000x10^{-8} = 40 x 10^6 Pa = 40MPa

$\sigma_{bend} = \frac{My}{I}$ where:

M = the internal bending moment about the section's neutral axis
y = the perpendicular distance from the neutral axis to a point on the section
I = the moment of inertia of the section area about the neutral axis

Q53.

Software	**Field of analysis**
Radiance	Lighting Analysis
Odeon	Acoustic design
Rayman	Outdoor thermal emission
Primavera	Construction management

Q54. Choose the best option

Group I	**Group II**
Nisargruna	Solid waste management
Vortex-DEWAT	Waste water treatment
Swale	Ground Water Discharge
BIPV	Renewable

Q55. Load = Pressure x Area = (Pressure x Area) for concrete + (Pressure x Area) for steel
Pu =0.4 fck Ac + 0.67 fy Asc ……..(E)
Pu = 0.4 x (8N/mm^2) x 62500 mm^2 (1-1/100) + 0.67 x 150N/mm^2 x 62500 mm^2 (1/100)
= 62500 [(0.4 x 8 x 0.99) + (0.67 x 150 x 0.01)]
= 62500 [3.168 + 1.005]
= 62500x13.218 = 260812N = 260 kN (**585 - 595 by GATE official**)

Where,
Pu= factored axial load on the member,
fck= characteristic compressive strength of the concrete,
Ac= area of concrete,
fy= characteristic strength of the compression reinforcement, and
Asc= area of longitudinal reinforcement for columns.

Please note that the equation (E) contains factor of safety (40% of strength of concrete & 67% of strength of steel). If we remove the factor of safety, the answer would be:
Axial Load = fck Ac + fy Asc
= (8N/mm^2) x 62500 mm^2 (1-1/100) + 150N/mm^2 x 62500 mm^2 (1/100)
= 62500 [8 x 0.99) + (150 x 0.01)]
= 62500 [7.92 + 1.5]
= 62500 x 9.42= 588750N = 588 kN **Answer**.
Answer: (585 - 595 by GATE official)

END OF THE ANSWER PAPER 2016

Number of Questions: 65
Total Marks: 100.0
Wrong answer will result in negative marks, (-1/3) for 1 mark Questions and (-2/3) for 2 marks Questions

1. The principal presented the chief guest with a (B) memento as token of appreciation.

2. Frogs (A) croak

3. Synonym of Educe is (C) Extract

4. Answer (C) 1
66□6 = 66-6/66+6 = 60/74
66◊6 = 66+6/66-6 = 74/60
Therefore, (66□6) →(66◊6) = (60/74)x(74/60) = 1

5. Answer (A) 343/125
Hope you remember,
$\log 10^2 = 2$, $\log 10^3 = 3$, $\log 10^4 = 4$ and so on. [Actually, $\log_{10}(10^2) = 2$]
So, $\log_x(5/7) = -1/3$
$\rightarrow x^{-1/3} = 5/7$
$\rightarrow x^{1/3} = 7/5$
$\rightarrow (x^{1/3})^3 = (7/5)^3$
$\rightarrow x = (7/5)^3 = 343/125$

6. Answer (A) ranks as axle of the leading causes of death

7. Answer (B) Human progress is contradictory to environmental security.

8. Answer: 3

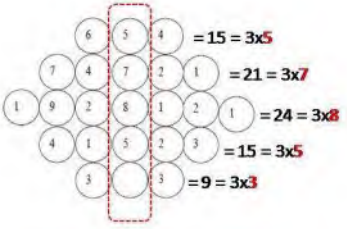


Figure: Solution of Q.No. 8

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

the center of the east-west axis on a mound which was itself almost certainly a very ancient sacred site. This original core was then expanded both towards the Nile in normal Egyptian fashion, but also in the direction of the outlying Mut temple to the south.

Figure: Remains the **Temple of Karnak.**

Figure: Remains the **Temple of Karnak.**

The huge entrance pylon is actually unfinished, as attested by the unequal height of its upper regions, the uncut clocks which project from its undecorated surfaces and the remains of the mud-brick construction ramp that is still present on its interior side. Originally, it stood some 40 meters high (131 feet). This structure may have been built as late as the 30th Dynasty by Nectanebo I, who at least constructed the temenos walls to which the pylon is attached. However, this is uncertain and it is possible that an earlier pylon once stood on the same spot. High upon this gate is an inscription left by Napoleon's Expedition, which is still visible.

Passing through this pylon, the first courtyard now encloses an area that was originally outside of the temple, as evidenced by a number of cryosphinxes like those outside that were displaced from their original positions along the processional route. Inside this courtyard to the left is the granite and sandstone triple barque chapel of Seti II, which contains three chambers for the barques of Mut (left), Amun (center) and Khonsu (right). Opposite this shrine is a small sphinx with the features of Tutankhamun.

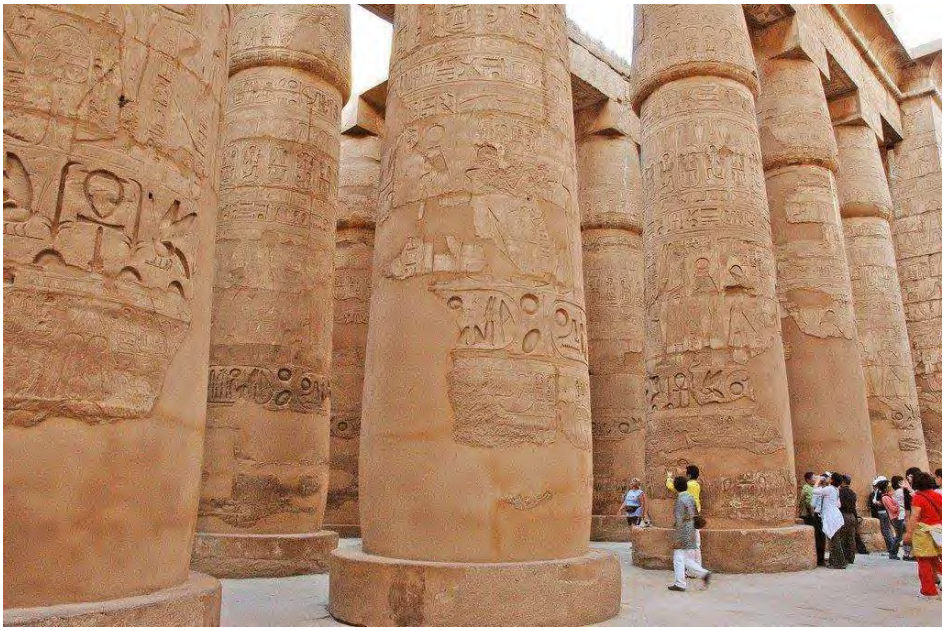


Figure: Remains the **Temple of Karnak.**

Centered within the courtyard are the remains of the kiosk of Taharqa, which was later usurped by Psammetichus II and later still, restored during Egypt's Greek Period. It originally consisted of ten huge papyrus columns linked by a low screening wall and open at its eastern and western ends. Now there is only one great column and a large, altar-like block of calcite (Egyptian alabaster). The function of this structure has been assumed to be a barque shrine but, because it is open to the sky, it has been suggested that the structure may have served another ritual purpose.

Notre Dame Cathedral is widely considered one of the finest examples of French Gothic architecture in the world. It was restored and saved from destruction by Eugène Viollet-le-Duc, one of France's most famous architects. The name Notre

Dame means "Our Lady" in French, and is frequently used in the names of Catholic church buildings in Francophone countries.The Notre Dame Cathedral was one of the first Gothic cathedrals, and its construction spanned the Gothic period. Its sculptures and stained glass show the heavy influence of naturalism, unlike that of earlier Romanesque architecture.

The Notre Dame Cathedral Paris was among the first buildings in the world to use the flying buttress (arched exterior supports). The building was not originally designed to include the flying buttresses around the choir and nave. After the construction began and the thinner walls (popularized in the Gothic style) grew ever higher, stress fractures began to occur as the walls pushed outward. In response, the cathedral's architects built supports around the outside walls, and later additions continued the pattern.

Figure: **Notre Dame Cathedral, Paris.**

The cathedral suffered desecration during the radical phase of the French Revolution in the 1790s, when much of its religious imagery was damaged or destroyed. During the 19th century, an extensive restoration project was completed, returning the cathedral to its previous state.

Figure: The Notre Dame Cathedral, one of Paris' most iconic landmarks was engulfed in flames on 15 April 2019.

QUESTION BANK

YEARS 2014 to 2008

Answer & Essential Notes

PART 4

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SET- 2

Q.1 Toothing is a construction technique used in
(D) **Brick masonry**

Q.2 'Skeleton and Skin' concept in building design and construction evolved during the
(C) **Gothic period**

Q.3 As per the IRC standards, the minimum width (in m) of a two lane urban carriageway without a raised kerb is
(C) **7.0**
The India Roads Congress (IRC) is the oldest and most important representative technical body of highway engineers in India.

Q.4 Pritzker Architecture Prize 2013 has been awarded to
(B) **Toyo Ito**

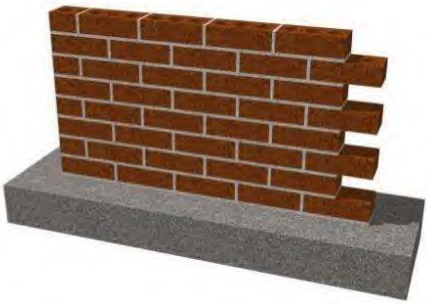


Figure: Toothing a very important technique when it comes to further extending the existing wall.

Toyo Ito has been announced as the Pritzker laureate for 2013. Ito is the thirty-seventh recipient of the Pritzker Prize and its sixth Japanese recipient.

Born in Seoul, South Korea, in 1941, Toyo Ito moved back to his father's native town of Suwa-shi Nagano in Japan soon after birth and graduated from Tokyo University in 1965. His ambition had always been to become a professional baseball player but he says that, as no university would give him a sport scholarship, he 'had no choice' but to study architecture. After his studies Ito worked for Japanese Metabolist architect Kiyonori Kikutake until 1969, before opening his own office in 1971.

His practice made its name with the introverted U-House in Tokyo (1976), clad in white masonry with no outward-facing openings. Instead the house looks into a central courtyard, with slits in the roof allowing a dramatic play of light in the minimal interior. Ito's work subsequently began to experiment more and more with diaphanous skins, holding lightness of structure and transparency as cardinal virtues. His own house, the Silver Hut in Nakano (1984), experimented with perforated and transparent screens in industrial materials to refer in a contemporary way to the lightness and translucency of traditional Japanese building methods. For Ito, industrial perforated aluminium can take on similar qualities to paper screens and movable walls, but the Silver Hut also has the qualities of an airship, with a taut, light skin stretched over a frame.

His most notable buildings after this period included the wonderful 'Tower of the Winds' in Yokohama (1986) – a light sculpture consisting of 1,300 flickering lamps configured to respond to the direction of the wind. His Old People's Home 'Hoju-ryo' (1994) and Municipal Museum (1991), both in Yatsushiro, were his first major institutional buildings. They launched a decade of success, including the Nagayama Amusement Complex in Tokyo (1993) and the almost completely transparent ITM Building in Matsuyama (1993), leading to his masterpiece, completed in 2001 – the Sendai Médiathèque. Seldom has a building been so eagerly awaited. Widely trailed in the architectural press before, during and after construction, the média¬thèque was conceived as a seven-storey structure, clad in glass and held up by branch-like steel members arranged in thirteen tubular columns housing services and allowing light to penetrate the depth of the floor plate. It is spectacular, at once referring to the characteristic trees that line the roads of Sendai and providing a 22,000-square-metre space of incredible lightness. The médiathèque derives its diagram from Le Corbusier's 1914 Dom-lno project, but also, again, refers to the movable screens and walls of the traditional Japanese house. The fit-out, with furniture and screens designed by Ross Lovegrove dividing the interior, has been criticized by some as being unsympathetic to Ito's structure, but it remains one of the most important buildings of recent years in Japan, and confirms Ito's place as the pre¬eminent voice in contemporary Japanese architecture.

Multiple Nuclei Theory

A model of town growth advanced by C. D. Harris and E. L. Ullman (*Annals of the American Academy of Political and Social Sciences*. 242) based on the fact that many towns and nearly all large cities grow about many nuclei rather than around a simple CBD. Some of these nuclei are pre-existing settlements, others arise from urbanization and external economies. Distinctive land-use zones develop because some activities repel each other; high-quality housing does not generally arise next to industrial areas, and other activities cannot afford the high costs of the most desirable locations. New industrial areas develop in suburban locations since they require easy access, and outlying business districts may develop for the same reason.

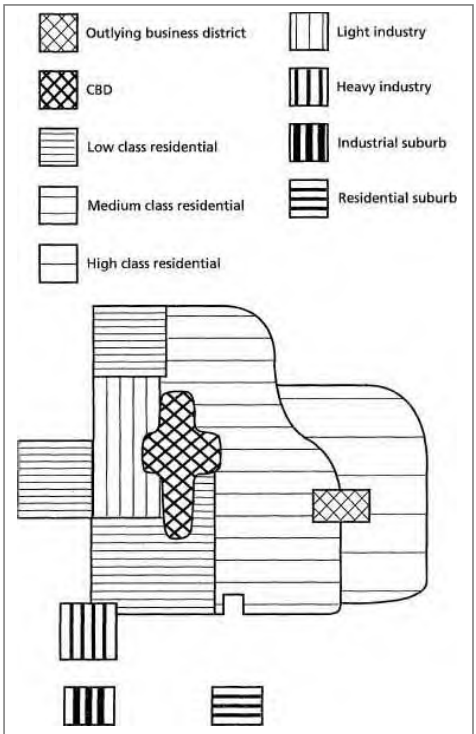


Figure: **Multiple Nuclei Theory** was advanced by C. D. Harris and E. L. Ullman

Sector Theory:

The view that housing areas in a city develop in sectors along the lines of communication, from the CBD outwards. High quality areas run along roads and also reflect the incidence of higher ground. Industrial sectors develop along canals and railways, away from high quality housing. Thus a high status residential area will spread out along the lines of the sector by the addition of new belts of housing beyond the outer arc of the city. Once contrasts in land use have developed in a sector near to the city, these contrasts will be perpetuated as the city grows. This theory was advanced by H. Hoyt (1939) as an alternative to Burgess' concentric model, and was based on residential rent patterns in the USA.

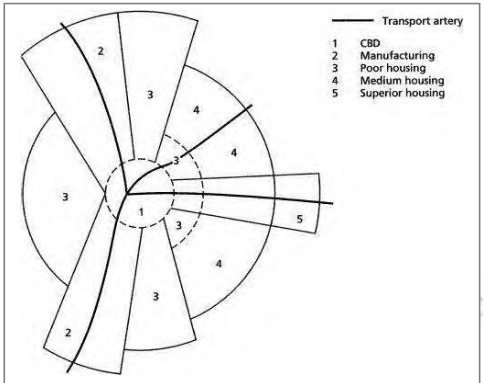


Figure: **Sector Theory** was advanced by H. Hoyt

Mann's model

This model of British urban development, proposed by P. Mann (1965), combines the sector theory with the concentric zone model. Four basic sectors are postulated: middle class, lower middle class, working class, and lower working class. Each sector displays four zones. In each case, there is the CBD, the transitional zone, a zone of smaller houses, and the outermost zone made up of post-1918 housing.

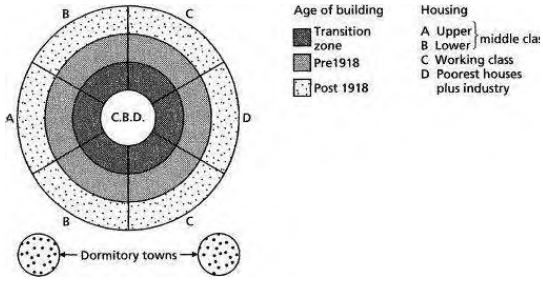


Figure: **Mann's model**

Q.31 (A) P-3, Q-1, R-2, S-4

Historic periods	Towns
Egyptian	Kahun
Greek	Miletus
Medieval	Montpazier
Renaissance	Versailles

Kahun, ancient Egyptian town, its site lying in modern Al-Fayyūm *muḥāfaẓah* (governorate). It was erected for the overseers and workmen employed in constructing the nearby pyramid of Al-Lāhūn, built by Sesostris II (reigned 1844–37 bce), and it was abandoned when the pyramid was completed. Excavated by the English archaeologist Sir Flinders Petrie (1888–90), it revealed a crisscross of streets laid out in a regular pattern, with houses built of mud brick having beamed, flat mud roofs, open courts and porticoes, and the earliest examples of a supporting wooden column, fluted and on a raised base. Cretan polychrome Kamáres ware and Cypriot black ware were also found at the site.

Miletus was an ancient Greek city on the western coast of Anatolia, near the mouth of the Maeander River in ancient Caria. Its ruins are located near the modern town of Balat in Aydin Province, Turkey. Before the Persian invasion in the middle of the 6th century BC, Miletus was considered the greatest and wealthiest of Greek cities.

Monpazier is a villege in southwest France. The village is a member of the *Les Plus Beaux Villages de France*("The most beautiful villages of France") association. Monpazier was built in 13th century.

Figure: A Greek City, Miletus (Layout & Ruins)

Q.32 (D) P-3, Q-1, R-2, S-4

Residential	Shopping, business	Industrial, manufacturing, and waste-related activities	Social, institutional, or infrastructure-related activities	Travel or movement	Leisure activities	Natural resources	No human activity or unclassifiable activity

Q.33 (B) P-3, Q-1, R-2, S-5

Books	Authors
Design of Cities	Edmond Bacon
On the Cultural Origin of Settlements	Amos Rapoport
Urbanization and National Development	Leo Jacobson and Ved Prakash
Planning Theory	Andreas Faludi

vibration produced by rumble strips alert drivers when they leave the traveled way. Rumble stripes is the term used for rumble strips painted with a retroreflective coating to increase the visibility of the pavement edge at night and during inclement weather conditions. **Rumble strips**, also known as **sleeper lines** or **audible lines.**

Q.4 ECBC stands for **(B) Energy Conservation Building Code**

Energy Conservation Building Code (ECBC), was launched by Ministry of Power, Government of India in May 2007, as a first step towards promoting energy efficiency in the building sector.
The ECBC provides design norms for:

- Building envelope, including thermal performance requirements for walls, roofs, and windows;
- Lighting system, including daylighting, and lamps and luminaire performance requirements;
- HVAC system, including energy performance of chillers and air distribution systems;
- Electrical system; and
- Water heating and pumping systems, including requirements for solar hot-water systems.

The code provides three options for compliance:

1. Compliance with the performance requirements for each subsystem and system;
2. Compliance with the performance requirements of each system, but with tradeoffs between subsystems; and
3. Building-level performance compliance.

Q.5 Age-Sex cohort for a state in India is obtained from **(A) Census of India**

The age structure of a population affects a nation's key socioeconomic issues. Countries with young populations (high percentage under age 15) need to invest more in schools, while countries with older populations (high percentage ages 65 and over) need to invest more in the health sector. The age structure can also be used to help predict potential political issues. For example, the rapid growth of a young adult population unable to find employment can lead to unrest.

Population Pyramid

A population pyramid illustrates the age and sex structure of a country's population and may provide insights about political and social stability, as well as economic development. The population is distributed along the horizontal axis, with males shown on the left and females on the right. The male and female populations are broken down into 5-year age groups represented as horizontal bars along the vertical axis, with the youngest age groups at the bottom and the oldest at the top. The shape of the population pyramid gradually evolves over time based on fertility, mortality, and international migration trends.

Q.6 'Cover block' is used as a building construction component in **(D) RC beam**

Figure: A **Cover Block** is essentially a spacer that is used to lift the rebar matrix off the ground so that concrete may flow underneath the rebar.

Q.7 'Villa Savoye', Paris is an example of **(A) Modernism**

The Villa Savoye is probably Corbusier's best known building from the 1950s, it had enormous influence on international modernism. It was designed addressing his emblematic "Five Points", the basic tenets in his new architectural aesthetic:

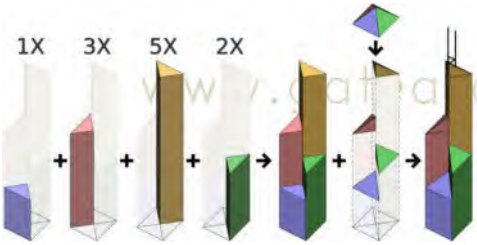
1. Support of ground-level pilotis, elevating the building from the earth and allowed an extended continuity of the garden beneath.
2. Functional roof, serving as a garden and terrace,

Figure: **Villa Savoye**

sciences and modern technologies. It incorporates some well lit exhibition areas, a museum, library, a 300-seat hall and a restaurant, as well as offices and car parking. Internally a superb feature is the glass and steel stairs and lift enclosure, which can be seen from most parts of the building.

Figure: **Institut du Monde Arab, Paris**

The Bank of China Tower: Triangular bracing and step-backs are structural adaptations to the high wind loads caused by Hong Kong typhoons.
369 meters high, 72 floors
When commissioned to design the Bank of China Tower, I.M. Pei wanted to create a structure that would represent the aspirations of the Chinese people yet also symbolize good will toward the British Colony. Original plans included an x-shaped cross-brace. However, in China the X shape is seen as a symbol of death. Instead, Pei opted to use less threatening diamond forms.
Another symbol used for this building is that of the bamboo plant, which represents revitalization and hope. The sectioned trunk of the Bank of China Building is inspired by the growth patterns of bamboo.
The four triangular shafts which form the building grow more narrow as the building rises. These shafts support the weight of the building and eliminate the need for many internal vertical supports. Consequently, the Bank of China uses less steel than typical for a building its size.



Scan here for further reading on **Bank of China Tower**

Figure: **The Bank of China Tower.**

The prism-like façade of the 367.4m Bank of China Tower has become one of Hong Kong skyline's most recognisable and appreciated features. The work of renowned Chinese–American architect I.M. Pei, the 70-storey building's asymmetrical form is pure geometry and has been compared to a bamboo plant, which extends its trunk successively higher with each new burst of growth.

Q27. Answer (B) Surface area of 4 interior walls = 2(5+3.5) x 3 = 51sqm
Surface area of door = 1mx2m= 2sqm
Surface area of window= 1mx1m= 1sqm
So, net surface area for plastering = 51-2-1= 48 sqm Answer

Q28. Answer (B)
Nominal Mix Concrete: In the nominal mix concretes the constituents of concrete are measured by volume and the proportions are pre- determine such as 1:8:16, 1:4:8 1;3;6 and 1:2;4 etc. The unit of measurement of cement is a bag of 50 kg having a volume of 0.035 cum. The batch boxes are made with the size 35x25x40cm which corresponds to one bag of cement. Nominal mix concretes 1:5:10, 1:4:8, 1:3:6, 1:2:4 and 1;1.5; 3 roughly correspond to M5, M7.5, M 10,M15 and M20 grades of concrete so far as their compressive strength is concerned.
M15 = 1:2:4 (cement:stone:sand)

This chart is a good depiction of differing CRIs, with each image having the same warm color temperature (2700K):

(Source: http://www.westinghouselighting.com/lighting-education/color-rendering-index-cri.aspx)

CRI	Lamp	Uses
22	high pressure sodium lighting	street lighting
62	common 4 foot fluorescent tube	office
80-85	compact fluorescent lighting (warm white)	residential
85	premium 4 foot fluorescent tube	retail
80-90	solid state LED lighting	residential
95	incandescent light bulb	residential
Lights with CRIs of 80 or higher are generally considered to have a high CRI. CRI values should only be compared when the light sources being compared have similar color temperature ratings.		

Q.36 (C) P-2, Q- 1, R-4, S-3

Terms	Architectural elements
Tympanum	Door or Window Bands
Proscenium	Auditorium Stage
Campanile	Church Tower
Dymaxion	Circular House

Figure: **Campanile** A bell tower is a tower that contains one or more bells, or that is designed to hold bells, even if it has none. In the European tradition, such a tower most

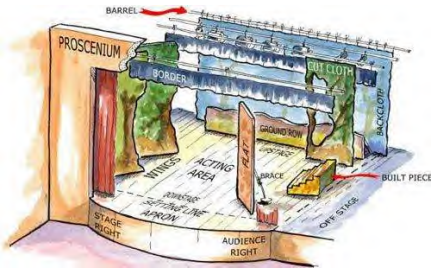


Figure: A **proscenium** is the area of a theatre surrounding the stage opening. A **proscenium** arch is the arch over this area.

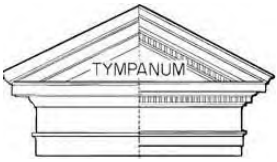


Figure: A **tympanum** (plural, tympana) is the semi-circular or triangular decorative wall surface over an entrance, bounded by a lintel and arch. It often contains sculpture or other imagery or ornaments.

QUESTION BANK

YEARS 2007 to 1991

Answer & Essential Notes

PART 5

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on the basis of age and sex.

5. The project Habitat, Montreal, designed by Moshe Safdie is an example of **(D) prefabricated housing**

Figure: The **Habitat, Montreal, designed by Moshe Safdie**.

The outcome of Safdie's thesis explorations, Habitat '67 in essence gives life to these ideas. The design for Habitat relies on the multiple use of repetitive elements, called boxes or modules, which were arranged to create 16 differently configured living spaces, for a total of 158 residences within the complex.

The environmental feature of Habitat expresses the architect's life-long commitment to creating salubrious and dignified living environments, by providing every dwelling with at least one garden (located on the roof-top of an underlying residence).

Figure: 354 prefabricated individual containers are stacked in a confused order and connected by steel cables.

6. The degree of freedom of a joint in a plane truss is **(B) three**

7. A brick cut lengthwise into two pieces so that each piece is half as wide as the full brick is called a **(D) Queen closer**

8. The strength of concrete increases with **(B) decrease in water cement ratio**

9. The point of contraflexure is the point where the **(C) bending moment changes its sign**

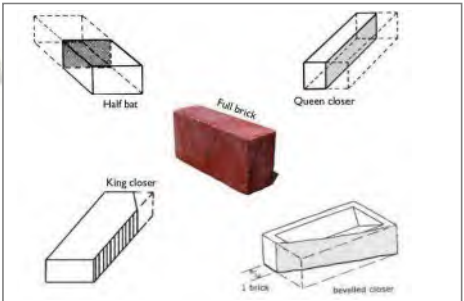


Figure: A brick nomenclature.

10. When wind loads are accounted for in the design of structures, the permissible stresses in the material are increased by **(C) 33.33%**

11. The term coined by Paolo Soleri that combines ecology with architecture and deals with habitants maintaining an extremely high population density is **(C) Arcology**

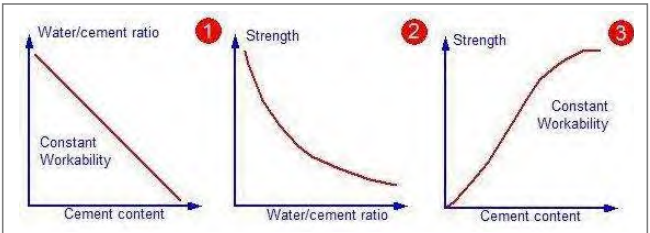


Figure: Effects of Water/cement ratio.

Paolo Soleri was an Italian architect. Best known for Arcosanti.

Also author of 'Arcology: City in the Image of Man'

Figure: Arcosanti (located in Arizona)

Arcosanti : The goal of Arcosanti (located in Arizona) is to explore the concept of arcology, which combines architecture and ecology. The project has the goals of combining the social interaction and accessibility of an urban environment with sound environmental principles, such as minimal resource use and access to the natural environment. The project has been building an experimental town on 25 acres.

Proxemics It is the study of spatial distances between individuals in different cultures and situations.

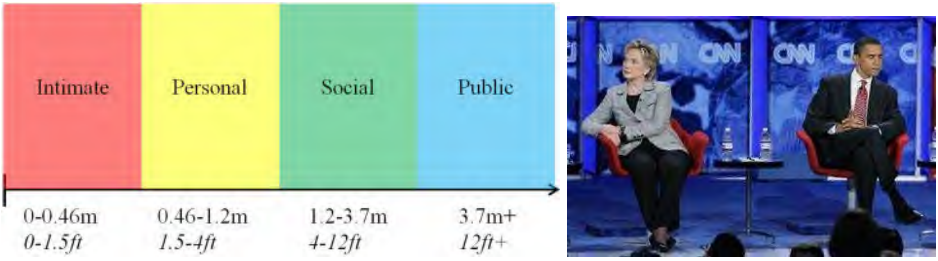


Figure: Definition of Proxemics with an example. It is the study of spatial distances between individuals in different cultures and situations.

1-Proxemics is a type of non verbal communication.
2-It is the study of how we communicate with the space around us.
3-It involves how we arrange personal space and what we arrange in it.

Utopia

Figure: "Plan Voisin," Le Corbusier

Imagined society can never exist. Still, the concept of a utopia has been very influential in the arts, especially for architects. At the beginning of the 20th century, the world was facing the devastation and destruction wrought by World War I. In architecture, the modemist movement was beginning to take shape, and architects believed that their buildings could help solve the world's problems. With new materials like glass, iron, and steel made available by the Industrial Revolution, modernist architects took to their drafting tables to imagine entirely new cities that supported utopian ideals and were devoid of the corrupted bourgeois sentiments often blamed for many of society's dilemmas.

Some utopian visions focused on new technology, others on open, untouched landscapes, and still others were based on new social orders, but all were united under radically avant-garde and cutting-edge architecture. While each architect's ideals varied, they all held one thing in common: they could never be built. Only able to exist in theory—the basis of a

Rem Koolhaas

Known for his striking, often gravity-defying structures, Rem Koolhaas has built a reputation as one of the top architects of the 21st century. Born in Rotterdam, the Netherlands, Koolhaas worked as a journalist and screenwriter before attending the Architecture Association School in London. After graduating in 1972, he conducted research in the United States, during which time he wrote *Delirious New York: A Retroactive Manifesto for Manhattan*. In 1975 he founded the Office for Metropolitan Architecture, or OMA, along with fellow architects.

The De Rotterdam complex, located in the Dutch city of the same name, was devised as a vertical city and is composed of three towers that house apartments, offices, shops, restaurants, and a hotel. At nearly 500 feet tall and with 1.7 million square feet of floor space across the towers, the building is the largest in the country. Designed by Rem Koolhaas

Koolhaas reinvented the skyscraper with his Beijing headquarters for CCTV. The building's two towers are connected by a 246-foot cantilevered section known as the Overhang. The exterior is sheathed in sun-shaded glass with a striking pattern of triangulated steel tubes, which form part of the support structure. Designed by Rem Koolhaas

Figure: Rem Koolhaas

Zaha Hadid's projects are characterized by their dynamic formal qualities of sinuously, curving shapes, or crystallized strata. This sums up as a kind of new Baroque, a sensuous, more vibrant and engaging type of architecture.

Q65. (C) P-1, Q-2, R-2, S-1

Q66. (B) P-3, Q-1, R-4, S-2

Quotation	Authors
Form follows function	Louis Sullivan
Imagination is more important than knowledge	Albert Einstein
Form follows climate	Charles Correa
We shape the buildings thereafter they shape us	Winston Churchill

"God is in the details." – *Mies van der Rohe*
"Architecture is the art of how to waste space." – *Philip Johnson*
"Form ever follows function." – *Louis Sullivan*
"Architects today tend to depreciate themselves, to regard themselves as no more than just ordinary citizens without the power to reform the future." – *Kenzo Tange*
"Architecture is the will of an epoch translated into space." – *Mies van der Rohe*
"Our time is so specialized that we have people who know more and more or less and less." – *Alvar Aalto*
"A hundred times have I thought New York is a catastrophe and 50 times: It is a beautiful catastrophe." – *Le Corbusier*
"Recognizing the need is the primary condition for design." – *Charles Eames*
"Architecture begins where engineering ends." – *Walter Gropius*
"No architecture can be truly noble which is not imperfect." – *John Ruskin*
"Architecture is the learned game, correct and magnificent, of forms assembled in the light." – *Le Corbusier*
"An idea is salvation by imagination." – *Frank Lloyd Wright*
"To create architecture is to put in order. Put what in order? Function and objects." – *Le Corbusier*
"But the building's identity resided in the ornament." – *Louis Sullivan*
"Less is more." – *Mies van der Rohe*
"It was the spirit animating the mass and flowing from it, and it expressed the individuality of the building." – *Louis Sullivan*
"Not many architects have the luxury to reject significant things." – *Rem Koolhaus*
"A doctor can bury his mistakes, but an architect can only advise his clients to plant vines." – *Frank Lloyd Wright*
"You've got to bumble forward into the unknown." – *Frank Gehry*
"I don't want to be interesting. I want to be good." – *Mies van der Rohe*
"Nothing is as dangerous in architecture as dealing with separated problems. If we split life into separated problems we split the possibilities to make good building art." – *Alvar Aalto*
"Architecture should speak of its time and place, but yearn for timelessness." – *Frank Gehry*
"Design is a plan for arranging elements in such a way as best to accomplish a particular purpose." – *Charles Eames*
"There will never be great architects or great architecture without great patrons." – *Edwin Lutyens*

Q67. (C) Q-1, T-3, V-4

Q68. (C) Racks & screen > Skimming tank > Sedimentation tank > Precipitation tank > Biological growth > Disinfection

Q69. (C) P, R
An *anaerobic filter* is a fixed-bed biological *reactor* with one or more *filtration* chambers in series. As *wastewater* flows through the filter, particles are trapped and *organic matter* is degraded by the active *biomass* that is attached to the surface of the filter material. *Anaerobic filters* are widely used as *secondary treatment* in household black- or *greywater* systems and improve the solid removal compared to *septic tanks* or *anaerobic baffled reactors*. Since *anaerobic filters* work by *anaerobic digestion*, they can be designed as anaerobic digesters to recover the produced *biogas*.

AR 13. What is 'Human Development Index'? What are the advantages of using this index?
Every year since 1990, the United Nations development programme has studied the quality of life in many countries. The Human Development Index is the result of this study. The index uses factors such as life expectancy, adult literacy rate and per-capita income to determine the rankings.

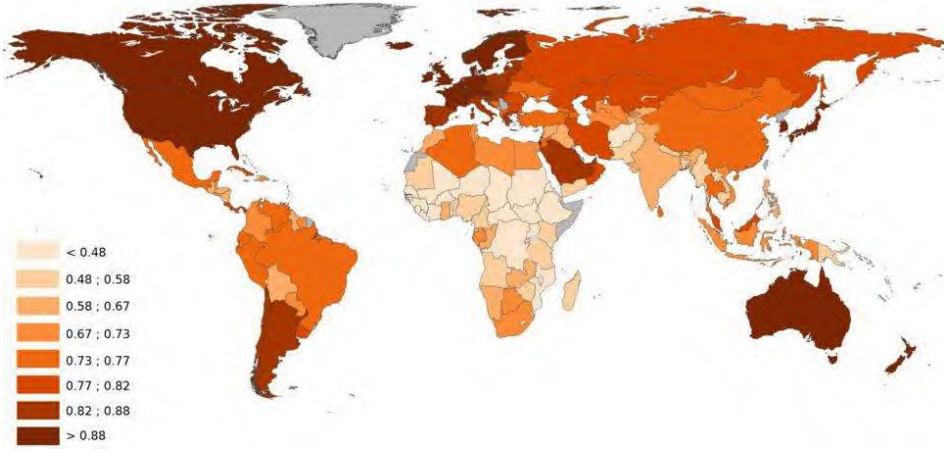


Figure: HDI worldwide

AR 14. State the important stages in land acquisition procedure while acquiring land for public purpose.

- *Publication of preliminary notification* by the Government that a particular land is needed or likely to be needed for a public purpose
- *Hearing of objections* to the above mentioned notification from interested parties by the collector and his report to the Government in this matter
- *Declaration by the Government* that the land is required for a public purpose
- *Notification by collector* declaring Government's intention to acquire land and calling for claims for compensation from interested parties
- *Enquiry into the compensation claims* and passing of award by the collector
- *Taking possession of the land* by the collector after payment of compensation and handing it over to the authority requiring the same

AR 16. What are various forms of non-property taxes that can be imposed by a multiplicity for mobilization of development funds?

- Betterment tax
- Professional tax
- Tax on real estate
- Water tax
- Sewerage tax etc.

AR 18. Indicate the factors to be considered for describing the economic profile of a region.

- Per-capita income
- Demographic content of the region
- Industrial scenario
- Service sector
- Trade and commerce
- Informal sector employment

AR 19. Mention various criteria for enlisting heritage structures and precincts.

- Uniqueness of the monument or site

can start and finish considering its predecessor activities. The latest start and finish times are the latest times that an activity can start and finish without delaying the project. LS and LF are found by working backward through the network. The difference in the latest and earliest finish of each activity is that activity's slack. The critical path then is the path through the network in which none of the activities have slack.

The variance in the project completion time can be calculated by summing the variances in the completion times of the activities in the critical path. Given this variance, one can calculate the probability that the project will be completed by a certain date assuming a normal probability distribution for the critical path. The normal distribution assumption holds if the number of activities in the path is large enough for the central limit theorem to be applied.

Since the critical path determines the completion date of the project, the project can be accelerated by adding the resources required to decrease the time for the activities in the critical path. Such a shortening of the project sometimes is referred to as *project crashing*.

SECTION B, PART II

11. **The design flow of the main sewer will be 0.69 litre/sec.**

First calculate population

Population = Density * Area = 250 person/hectare * 2 sq.Km = (250 person/10000 sq.m) *(2000sq.m)
= 500 person

Quantity of sewage = 500 person * 120 litres per capita per day = 60000 litres per day = 60000/24*3600 litres/sec
= 0.69 litre/sec Answer.

20. a) **Explanation of the concept of relief displacement on aerial photography.**

Illustration of deformation of an **aerial** image according to the distance from the nadir point, i.e. the centre of the image. A vertical object (such as a building, for instance) will appear to be lying along a line radial to the image nadir point. This deformation is called **relief displacement**.

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

This relief displacement underlie the following principles:

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

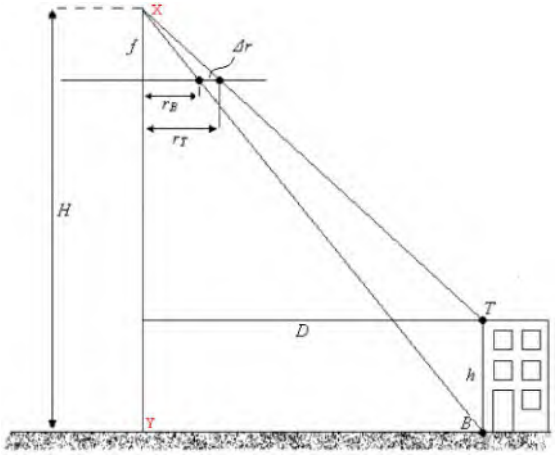


Figure: X is the perspective center, Y is the image nadir point

Relief Displacement: Calculating Height

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

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

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

And

1. Ratio 'Golden Mean' is: **(B) 1: 1.618**

2. 'Mihrab' is found **(C) on the west wall of a mosque**

3. Which one falls under Indo-Sarasanic architecture? **(B) Taj Mahal**

4. Which of the following is **not** a function of a good mulch: **(C) Encourage weed growth**

5. Byzantine architecture is famous for: (D) **New type dome construction**

6. 'Gopuram' refers to (B) **Gateway**

7. Most efficient arch in transferring load: **(D) Catenary**

Notes: The catenary curve is interesting because there are many examples of it in the world around us. The best way to visualize a catenary curve is to imagine the shape of a hanging chain. (The word comes from the Latin word *catena* meaning "chain.") Catenaries are used in engineering and architecture, for example in the shape of hanging bridges, or when inverted, in the shape of some arches. One of the most impressive examples is the St. Louis Gateway Arch. Catenaries can also be found in nature, for example in the curve of a spider web.

At first glance, catenaries might look like parabolas, but they have a completely different formula. The formula gives a shape that has a special structural property when used as an arch. When the chain shape is inverted into an arch and divided into building blocks, the blocks can support each other by gravity alone. To fully understand how catenaries differ from parabolas and why chains take the shape of catenary curves, we need some calculus background which is out of syllabus.

Figure: St. Louis Gateway Arch *by Eero Saarinen*

8. Dimension of Corbusier's modular human scale are in: **(B) Geometric Progression**

9. Find odd one out of the following: **(A) T-trap**

10. pH value of treated domestic water supply should be between : **(C) 6.5- 8.0**

11. PERT is **(D) Event oriented**

12. Gypsum is added in cement manufacture for the property of: **(B) Retarding the setting time**

13. Critical path in CPM connects the initial and end events and: **(B) consists of events all having maximum slack times**

14. Maximum distance for discerning facial expression in a theatre: **(A) 12.5 m**

15. Outer layer of timber log is **(C) Sap wood**

BUILDING SERVICES CONSTRUCTION & MANAGEMENT

By
Faculty of Architecture

GATE ARCHITECTURE 2020

gatearchitecture.com

Introduction

As the name of this section suggests, it is meant for to recap the maximum part of the syllabus in minimum possible time. This is a part of GATE ARCHITECTURE 2018 complete set. It covers through short notes on different topics of the syllabus.

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

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

Contents

Section 2: Building Materials, Construction and Management

Behavioral characteristics and applications of different building materials

Timber

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

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

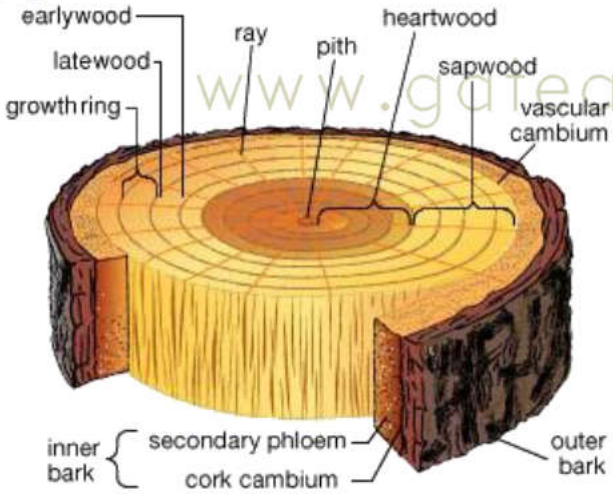
All wood is composed of cellulose, lignin, hemicelluloses, and minor amounts (5% to 10%) of extraneous materials contained in a cellular structure.

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

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

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

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



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

Softwood trees include pines, spruces, firs , cedars.

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

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

Plywood

This is a product made from an odd number (three, five ...) of thin layers (veneers) of wood (generally hardwoods) bonded together by an adhesive. The alternate plies are at right angles thus ensuring that the resulting material has a high uniform strength in all directions.

Plywood does not split as easily as conventional wood and has a good dimensional stability under conditions of varying moisture conditions. Plywood will not easily split if a nail is close to any edges. Plywood can be considered as a high strength construction material used for internal and external load bearing panels.

Plywood is normally supplied as 1,2m x 2,4m sheets in thickness from 3 to 25mm thickness

Chipboard

Chipboard is made from particles of wood bonded together with a synthetic resin and sometimes other binders. The panels are generally 2,4m x 1,2m with thicknesses from 3mm to 40mm. Larger sizes are available up to 5m x 1,5m. The particles are obtained from forrest thinnings sawdust and small pieces of wood unsuitable for other uses are granulated to chips. The resin used is generally urea formalehyde. Chipboard is normally only suitable for interior use in the manufacture of low cost furniture, wall panels and floor panels.

MDF (Medium Density FibreBoard)

There are different types fibreboard which differentiated by
..the size and type of wood fibres used
..the method of heating
..what type of bonding agent is used
..the method by which it is pressed into shape

Medium Density Fibreboard (MDF) is a wood substitute form which is made from fine wood fibres in a resin which is bonded under heat and pressure. It is manufactured by a dry process at a lower temperature than other fibreboards e.g hardboard. The natural glues and resins contained within the wood are not effective. MDF therefore uses artificial bonding agents / resins. The resin used is usually urea formaldehyde, but some fibreboard including exterior or marine quality board will use stronger glues such as phenol formaldehyde. MDF may be used instead of plywood or chipboard. It is dense, flat, stiff, has no knots and is easily machined. It is made up of fine particles and therefore does not have an easily recognisable surface grain

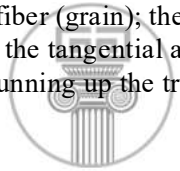
MDF can be painted to produce a smooth quality surface. Because MDF has no grain it can be cut, drilled, machined and filed without damaging the surface. MDF may be dowelled together and traditional woodwork joints may even be cut. MDF may be glued together with PVA wood glue. Oil, water-based paints and varnishes may be used on MDF. Veneers and laminates may also be used to finish MDF

Safety: It should be noted by anyone involved with MDF that there is an accepted risk that wood dust inhaled at certain level, is a carcinogen (cancer causing) and that formaldehyde is possibly carcinogenic to humans'. Exposure to formaldehyde by inhalation can cause irritation to the eyes, nose, throat and mucus membrane.formaldehyde can also cause dermatitis. A number of countries have but legal limitations on the use of MDF

Strength of wood

Wood is a natural product and its properties vary continuously throughout processing from when the tree is cut down. Green wood has high moisture content (generally) and this results in reduced strength. As it is dried it loses the moisture content and becomes stronger.

Wood may be described as an orthotropic material; that is, it has unique and independent mechanical properties in the directions of three mutually perpendicular axes: longitudinal, radial, an d tangential. The longitudinal axis is assumed parallel to the fiber (grain); the radial axis is normal to the growth rings (perpendicular to the grain in the radial direction); and the tangential axis is perpendicular to the grain but tangent to the gro wth rings. (Think of the grain as the tree rings running up the trunk /branch - planks of wood are simply sections of the tree trunk (or branch)



FRP

Fiberglass Reinforced Plastic Panels (FRP) are modern composite materials that have become popular in the construction industry. These panels are made from a combination of glass fibers and plastics. The fibers act similar to beams in a house, reinforcing the structure of the polymer, making it more stable and strong. A fiberglass reinforced panel used in construction usually has the following components:

- A base polymer, usually, plastics like polyester
- A fiberglass reinforcement
- Other additives to improve desirable qualities like fire resistance, and opacity to UV rays
- Surface veils for a smooth finish and extra durability

Panels made from fiberglass reinforced plastics are lightweight, yet strong and flexible. They are quite superior to traditional building materials like wood and metal on several counts.

It offers the architect unlimited design flexibility due to its molded shape potential. From columns to cornices, Fiberglass (FRP) has been used around the world to add decorative dimensionality to projects while being a cost alternative to many traditional building materials.

Fiberglass reinforced polymers (FRP) is a lightweight, versatile and durable construction material for exterior architectural detailing. FRP is used to create columns, capitals, moldings, domes, decorative balustrades, pergolas, rafter tails, entablatures, pediments, rakes, brackets, quoins, window and door surrounds or any architectural feature you wish to create. Fiberglass is extremely versatile. It can be molded and produced in practically any shape. FRP parts can be made on a radius or ellipse. You can have letters preformed in the fiberglass parts to mimic the look of chiseled stone words on building facades.

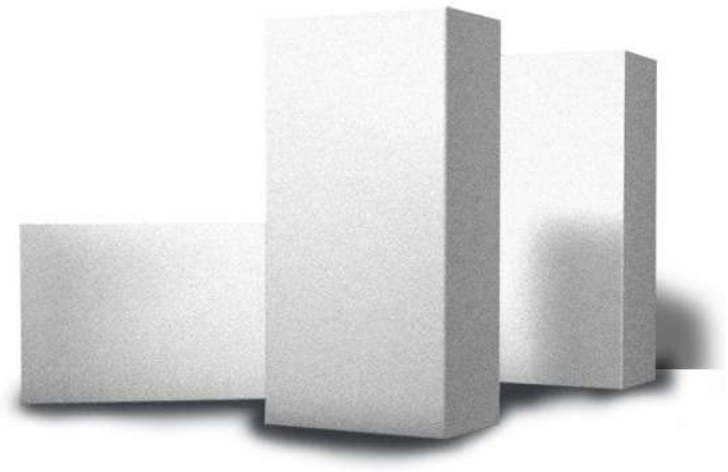
There are great advantages to specifying and installing fiberglass on your construction project. Fiberglass is lightweight with strong and durable properties. Since it is lightweight, FRP enables the building design to require less structural load requirements, thus reducing costs for the project.

FRP can be supplied several ways. For many projects, FRP is supplied unpainted. This enables the installer to attach the FRP to the structure with the ability to countersink screws, patch the screw holes with body filler and sand the screw holes flush with the fiberglass surface. The entire project is then primed and painted giving the material a uniform, finished appearance.

FRP can also be supplied with a gel coated colored finish. Almost any color can be achieved. Some projects require that the FRP arrive to the jobsite with a finished coat. When specifying a finished FRP, there are certain things to take into consideration. Firstly, there needs to be strong communication between the architect, construction manager, supplier and installer. Prefinished FRP needs to handled and installed properly to protect the finish. Screws need to be strategically installed to minimize the number of exposed areas on the surface of the material.

A third process for producing fiberglass is with a simulated stone finish. This can give the FRP the appearance of limestone and other stone finishes. The same planning and care must be followed for handling and installation the stone finished FRP as with the gel coated colored FRP.

AAC Blocks



Estimation, specification, valuation

Cost & Estimation

Types Of Estimates

The estimates may be divided in to the fol lowing categories:-

(1) Preliminary or Approximate estimate.
(2) Rough cost estimate based on plinth area.
(3) Rough cost estimate based on cubic contents.
(4) Detailed estimate.
(5) Annual repair estimate.
(6) Special repair estimate.
(7) Revised estimate
(8) Supplementary estimate.

1. Preliminary or Approximate estimate

This estimate is prepared to decide *financial aspect*, *policy* and to give idea of the cost of the proposal to the competent sanctioning authority. It should clearly show the necessity of the proposal and how the cost has been arrived at

The calculations for approximate estimate can be done with the following data. The data can be had from a similar construction already complete in the nearby area, executed by the department.

For example: To calculate approximate estimate for a Hospital, per bed cost is calculated from the recent completed hospital and is multiplied with the number of beds required. Similarly for a house, per square metre plinth area is calculated and is multiplied with the proposed covered area. The specifications should also be same. For a road, expenditure of per kilometer length is taken, width also plays the role.

The following documents should be attached with it.

(a) Detailed report

(b) Site plan of the p roposal

(c) It should also clearly mention about the acquisition of land, Provision of

electric and water supply etc.

2. Plinth area Estimate (Based on Rough Cost)

Plinth area of a building means Length x Breadth (roofed portion only) excluding plinth offsets. The estimates are prepared on the basis of plinth areas of the various buildings proposed to be constructed. The **rates** are being arrived at the dividing the total cost of construction with its plinth area. For example if total cost of a building is

Rs. 2 lac and its plinth area is 50 sq. m. then plinth area rate =2,00,000 = Rs.4000/ - per

50

sq.m. Using this rate as basis of the next construction, approximate or rough cost of the proposal can be arrived at by multiplying the plinth area of the proposed building with this plinth area rate.

The following documents are attached with the estimate.

(a) Line plan with brief specifications.
(b) Cost of various services added i.e. electric and water supply etc.
(c) North line should be shown clearly on line plan.

3. Cubic Contents Estimate (Based on Rough Cost)

The cubic contents of a building means plinth area x height of the building. The height is taken from top of floor level to top of roof.

The cubic contents of the proposed building are multiplied with cubic rates arrived at for the similar construction i.e. total cost of construction divided by cubic contents = cost per cubic metre.

4. Detailed Estimate

After getting Administrative approval on rough cost estimate, detailed estimates are prepared.

In this, the estimate is divided in to sub-heads and quantities of various items are calculated individually.

In the end of the detailed quantities, an *abstract* of *cost* giving quantities of each item and rate of every item according to the sanctioned schedule of rates shall be attached. In case of non-schedule rates i.e. rates which are not given in the sanctioned schedule of rates, proper analysis of rates shall be attached. If however the work proposed to be constructed is located in a remote place, the provision for the carriage of the material shall be added in the estimate to avoid any excess over the administratively approved estimate later on. Detailed specifications & report should also be attached with the estimate. Technical sanction is given on detailed estimate.

The detailed estimate shall also provide for the cost of approach road, water supply, electric installations and acquisition of land etc, so as to call it a comprehensive estimate.

5. Annual repair estimate

In order to keep building and roads in perfect condition, annual repairs should be carried out as follow: -

(i) In case of a building-white washing, oiling and painting of doors and windows, cement plaster repairs (inside & outside), repairs of floors etc. In no case this annual repair amount should increase more that 11/2% to 2% of the capital cost of the building.

(ii) In case of a road-filling patches, maintenance of berms etc.

6. Special repair estimate

If the work cannot be carried out of the annual repair funds due to certain reasons resulting in the genuine increase in cost, then special repairs estimate is to be prepared.

The reason of increase may be:-

(i) In case of a building-opening of new doors, change of floors, replastering walls etc.

(ii) In case of roads-if the whole surface is full of corrugation & patches, then the total surface is to be scarified. The old metal is taken out, consolidation by adding more metal is done and top surface is repainted.

7. Revised estimate

When the sanctioned estimate exceeds by 5% either due to the rate being found insufficient or due to some other reasons, a fresh estimate is prepared which is called a Revised Estimate. A comparative statement on the last page of the estimate is attached giving there in the reasons of the increase of cost in case of each item.

8. Supplementary Estimate

This is fresh detailed estimate in addition to the original sanctioned estimate prepared when additional works are deemed necessary during the progress of a work to supplement the original works. The abstract of cost should show the amount of the original sanctioned estimate as well as the supplementary amount of the original sanctioned estimate as well as the supplementary amount for which sanction is required.

Methods of Taking out Estimates

The calculations of quantities of materials can be done using various methods of estimates. The application of an individual method depends upon the design and shape of the building. The different methods are as under:

1. Centre line method.
2. Crossing method.
3. Out to out and in to in method.
4. Bay method.
5. Service unit method.

PERT/CPM for Project Scheduling & Management

1. 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.

1.1 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 Ordinance Research Computer (NORC) at Dahlgren, Virginia.

1.2 Planning, Scheduling & Control

Planning, Scheduling (or organising) and Control are considered to be basic Managerial functions, and CPM/PERT has been rightfully accorded due importance in the literature on Operations Research and Quantitative Analysis.

Far more than the technical benefits, it was found that PERT/CPM provided a focus around which managers could brain-storm and put their ideas together. It proved to be a great communication medium by which thinkers and planners at one level could communicate their ideas, their doubts and fears to another level. Most important, it became a useful tool for evaluating the performance of individuals and teams.

There are many variations of CPM/PERT which have been useful in planning costs, scheduling manpower and machine time. CPM/PERT can answer the following important questions:

How long will the entire project take to be completed? What are the risks involved?

Which are the critical activities or tasks in the project which could delay the entire project if they were not completed on time?

Is the project on schedule, behind schedule or ahead of schedule?

If the project has to be finished earlier than planned, what is the best way to do this at the least cost?

1.3 The Framework for PERT and CPM

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

I. Define the Project and all of it's significant activities or tasks. The Project (made up of several tasks) should have only a single start activity and a single finish activity.
II. Develop the relationships among the activities. Decide which activities must precede and which must follow others.
III. 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.
IV. Assign time and/or cost estimates to each activity
V. Compute the longest time path through the network. This is called the critical path.
VI. 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?

Introduction

to

Building Services

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

Contents

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

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

Introduction

Building Services are the electrical, plumbing, and mechanical systems in a building. For this reason they are also called MEP services, for mechanical, electrical, and plumbing.

A comprehensive list of services that could be provided in a building follows:

Mechanical Services

1. Firefighting Systems
2. Elevators & Escalators
3. HVAC Systems (heating, ventilation, and air-conditioning systems)
4. Gas Supply Systems (such as for heating and cooking in residential buildings, or oxygen and nitrogen in hospitals)
5. Compressed Air Systems used in industries

Electrical Services

1. Power Supply
2. Backup Power (such as diesel generators)
3. Emergency Power (such as battery-based uninterrupted power supply)

Plumbing Systems

1. Water Supply
2. Drainage of Wastes
3. Water Recycling Systems (these allow you to recover the water from your waste and re-use that water for low-grade applications such as flushing)
4. Rainwater Harvesting
5. Storm Water Drainage

Data based Systems or Low-Voltage Systems

1. Security Systems
2. Fire Alarm Systems
3. Building Management Systems
4. Public Address Systems
5. Cable TV Systems
6. Data Networks
7. Voice Networks

1. Heating System

Thermal resistance of materials

The thermal resistance of a slab of homogeneous material is calculated by dividing its thickness by its thermal conductivity:

$$R = \frac{l}{\lambda}$$

where R is the thermal resistance (m^2K/W), l is the thickness of the slab (m) and λ is the thermal conductivity (W/mK). Resistance to heat flow by a material depends on its thickness, density, water content and temperature. The latter two parameters result from the material's location within the structure. Insulating materials are usually protected from moisture and the possibility of physical damage as they are of low density and strength. The thermal conductivity of masonry can be found from the bulk dry density and the moisture content, which depends on whether it is exposed to the climate or is in a protected position.

Example 1.1 Find the thermal resistance of a 110 mm thickness of brickwork inner leaf.

λ=0.62 W/mK (given) and l = 0.11 m.

$$R = \frac{l}{\lambda} = \frac{0.11}{0.62} = 0.1774 \text{ m}^2\text{K/W}$$

Example 1.2 A designer wishes to replace 200 mm thick heavyweight concrete blocks in the design of a wall with fibreboard having the same thermal resistance. What thickness of fibreboard could be used?

Given, λ=1.63 W/mK for the heavyweight concrete block and λ=0.6 W/mK for the fiberboard.

R (concrete) = 0.200 / 1.63
R (fiberboard) = l / 0.06
So, for the same resistance,
0.200 / 1.63 = l / 0.06
Hence,
l = 7.4 mm Answer.

Thermal transmittance (U value)

Thermal transmittance is found by adding the thermal resistances of adjacent material layers, boundary layers of air and air cavities, and then taking the reciprocal. Boundary layer or surface film thermal resistances result from the near-stationary air layer surrounding each part of a building, with an allowance for the radiant heat transfer at the surface. Heat transmission across cavities depends upon their width, ventilation and surface emissivities. The external surface resistance depends upon the building's exposure.

Example 1.3 An external wall consisting of 105 mm brick, 50 mm unventilated cavity, 105 mm brick and 13 mm dense plaster has a severe exposure. Find its U value.

Shear Force and Bending Moment Diagram:

Introduction:

The advantage of plotting a variation of shear force F and bending moment M in a beam as a function of 'x' measured from one end of the beam is that it becomes easier to determine the maximum absolute value of shear force and bending moment.

Further, the determination of value of M as a function of 'x' becomes of paramount importance so as to determine the value of deflection of beam subjected to a given loading.

Construction of shear force and bending moment diagrams:

A shear force diagram can be constructed from the loading diagram of the beam. In order to draw this, first the reactions must be determined always. Then the vertical components of forces and reactions are successively summed from the left end of the beam to preserve the mathematical sign conventions adopted. The shear at a section is simply equal to the sum of all the vertical forces to the left of the section.

When the successive summation process is used, the shear force diagram should end up with the previously calculated shear (reaction at right end of the beam. No shear force acts through the beam just beyond the last vertical force or reaction. If the shear force diagram closes in this fashion, then it gives an important check on mathematical calculations.

The bending moment diagram is obtained by proceeding continuously along the length of beam from the left hand end and summing up the areas of shear force diagrams giving due regard to sign. The process of obtaining the moment diagram from the shear force diagram by summation is exactly the same as that for drawing shear force diagram fr om load diagram.

It may also be observed that a constant shear force produces a uniform change in the bending moment, resulting in straight line in the moment diagram. If no shear force exists along a certain portion of a beam, then it indicates that there is no change in moment takes place. It may also further observe that dm/dx= F therefore, from the fundamental theorem of calculus the maximum or minimum moment occurs where the shear is zero. In order to check the validity of the bending moment diagram, the terminal conditions for the moment must be satisfied. If the end is free or pinned, the computed sum must be equal to zero. If the end is built in, the moment computed by the summation must be equal to the one calculated initially for the reaction. These conditions must always be satisfied.

Illustrative problems:

In the following sections some illustrative problems have been discussed so as to illustrate the procedure for drawing the shear force and bending moment diagrams

1. A cantilever of length carries a concentrated load 'W' at its free end.

Draw shear force and bending moment.

Solution:

At a section a distance x from free end consider the forces to the left, then F = -W (for all values of x) -ve sign means the shear force to the left of the x -section are in downward direction and therefore negative

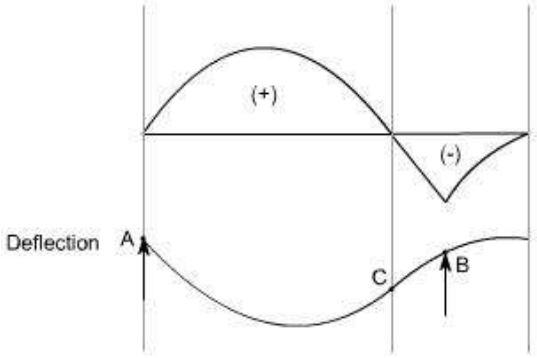
Taking moments about the section gives (obviously to the left of the section)

M = -Wx (-ve sign means that the moment on the left hand side of the portion is in the anticlockwise direction and is therefore taken as –ve according to the sign convention)

so that the maximum bending moment occurs at the fixed end i.e. M = -W l

From equilibrium consideration, the fixing moment applied at the fixed end is Wl and the reaction is W. the shear force and bending moment are shown as,

The bending moment diagram is partly positive and partly negative.If we plot the deflected shape of the beam just below the bending moment



Common Relationships

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

This diagram shows that L.H.S of the beam 'sags' while the R.H.S of the beam 'hogs'

The Relationship Between Load, Shear and Bending Moment

$$w(x) = \text{the load function}$$

$$V(x) = \int w(x)dx$$

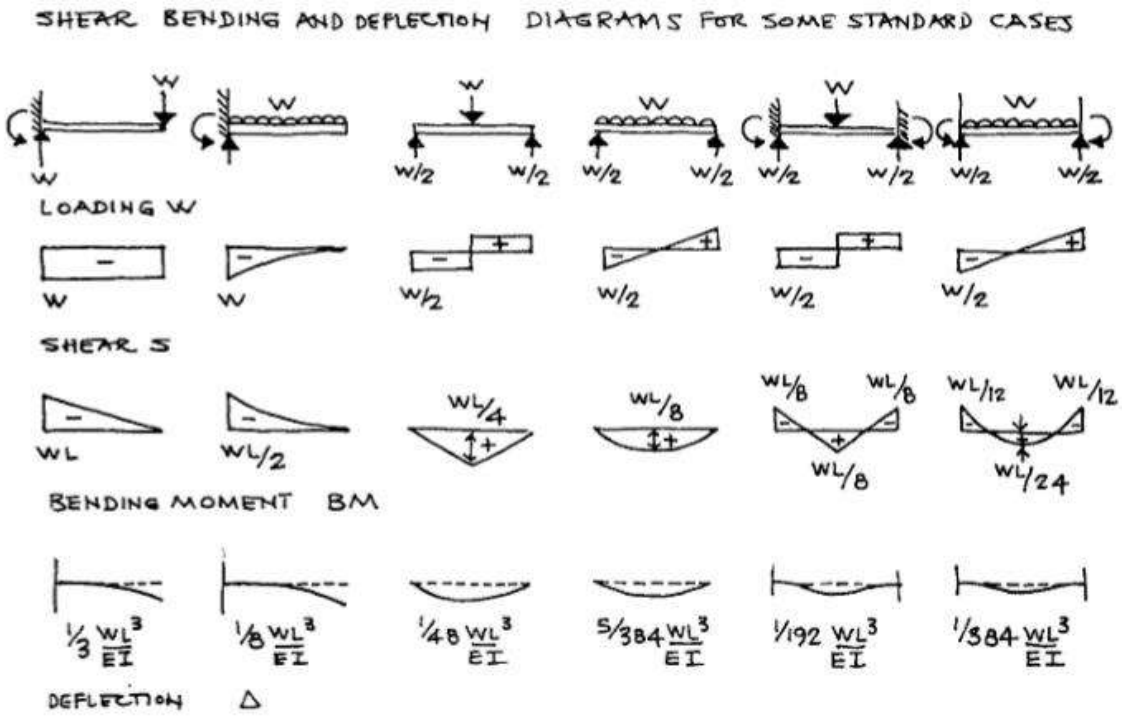
$$M(x) = \int V(x)dx$$

The point C on the beam where the curvature changes from sagging to hogging is a point of contraflexure.

OR

It corresponds to a point where the bending moment changes the sign, hence in order to find the point of contraflexures obviously the B.M would change its sign when it cuts the X-axis therefore to get the points of contraflexure equate the bending moment equation equal to zero.The fibre stress is zero at such sections

Note: there can be more than one point of contraflexure.



GATE SYLLABUS 2018: General Aptitude (15 marks)

Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.

Numerical Ability Questions:

In the exams, you may encounter challenging numerical reasoning questions. Such challenging numerical reasoning questions require problem-sloving heuristics (set of rules) in addition to the four basic operations (addition, subtraction, multiplication and division). Below are the 11 useful heuristics you can adopt to s olve difficult questions.

1. Use Diagrams / Models
2. Act it Out
3. Use Before & After
4. Use Systematic Listing
5. Look for Patterns
6. Work Backwards
7. Use Guess & Check
8. Simplify the Problem
9. Make Supposition
10. Solve Part of the Problem
11. Paraphrase the Problem

---

1. In the first 10 overs of a cricket game, the run rate was only 3.2. What should be the run rate in the remaining 40 overs to reach the target of 282 runs?

A.6.25 B.6.5
C.6.75 D.7

Answer: Option **A**
Explanation:

Required run rate = $\frac{282 - (3.2 \times 10)}{40} = \frac{250}{40} = 6.25$

---

2. The captain of a cricket team of 11 members is 26 years old and the wicket keeper is 3 years older. If the ages of these two are excluded, the average age of the remaining players is one year less than the average age of the whole team. What is the average age of the team?

A. 23 years B. 24 years
C. 25 years D. None of these

Answer: Option **A**

Explanation: Let the average age of the whole team by x years.

$\therefore 11x - (26 + 29) = 9(x - 1)$
$\Rightarrow 11x - 9x = 46$
$\Rightarrow 2x = 46$
$\Rightarrow x = 23.$
So, average age of the team is 23 years.

---

3. The average age of husband, wife and their child 3 years ago was 27 years and that of wife and the child 5 years ago was 20 years. The present age of the husband is:

A. 35 years B. 40 years
C. 50 years D. None of these
Answer: Option **B**

Explanation: Sum of the present ages of husband, wife and child = (27 x 3 + 3 x 3) years = 90 years.

URBAN PLANNING & DESIGN

GATE ARCHITECTURE 2020

By
Faculty of Architecture

gatearchitecture.com

Introduction

One of major reasons to score low in GATE exam for B.Arch students is that few are fully aware that GATE AR is for both of B.Arch & B.Plan. So, a quite well n umber of questions would be asked in exam covering B. Planning section.

This is a reason you have this booklet. Please note that we have covered in depth the section about town planners, theories and their contribution in Question-Bank itself. Therefore we have minimized those sections here.

Urban planning and design more of theories, stories, concepts etc. We have randomly selected topics from the syllabus and put into concise and bullet form as far as possible.

You should read this booklet as a complementary to the complete set.

GATE SYLLABUS 2018 [Contents covered in this section are highlighted]

Section 5: Urban Design Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

Section 6: Urban Planning and Housing Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.

City Planning

Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.

Urban Design

What is urban design?

Unfortunately, there are no hard and fast rules related to urban design. A structural beam in a building must meet certain requirements for that building to stand. A road must be built in a certain way to avoid future potholes.

Urban design, however, is not a series of rules and standards. Rather, it is a group of concepts that, once understood, can lead to a fresh way of perceiving streets, buildings, and spaces -- and insights into why certain places are appealing and others are not. With urban design concepts in mind you should be able to better question architectural presentations and consider the impact of development proposals on your town's character.

Introduction to urban design

When walking down the street you see a place that appears interesting and inviting. Across the street you glance at another area but it looks unappealing and uncomfortable. Which place would you rather be? That's easy to answer. The more difficult question is: Why? What is it that creates a place that people like and use? Understanding some of the ideas of urban design can help us better answer this question. Urban design does not have to be a mystery. Knowing a few important concepts can make it easier for you to observe what works – and what doesn't – as you stroll through your town, or as you review a project application.

Urban design is concerned with the arrangement, appearance and function of our suburbs, towns and cities. It is both a process and an outcome of creating localities in which people live, engage with each other, and engage with the physical place around them.

Urban design involves many different disciplines including planning, development, architecture, landscape architecture, engineering, economics, law and finance, among others.

We can also say, Urban design is the art of making places for people. It includes the way places work and matters such as community safety, as well as how they look. It concerns the connections between people and places, movement and urban form, nature and the built fabric, and the processes for ensuring successful villages, towns and cities.

Urban design operates at many scales, from the macro scale of the urban structure (planning, zoning, transport and infrastructure networks) to the micro scale of street furniture and lighting. When fully integrated into policy and planning systems, urban design can be used to inform land use planning, infrastructure, built form and even the socio - demographic mix of a place.

	Architecture	**Urban Design**	**Urban Planning**
Scale	Individual building	Space between buildings: Street, park, transit shop	Whole neighborhood, districts & cities
Orientation	Aesthetic and functional	Aesthetic and functional	Unity
Treatment of space	2D & 3D	3D	Predominantly 2D
Time frame	No definite time frame	Short Term (< 5 years)	Long term (5 to 20 years)

Concepts of urban design

Key urban design concepts are:

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

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

Physical Comfort

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

Circulation and Accessibility

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

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

Transitions and Boundaries

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

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

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

PLANNING PROCESS:

All stages of actions from defining the objectives till implementation and review of any planning project in the planning process. In plan preparation, the physical planning should associate with the socio-economical, geographical, political factors, for achieving the objective in desired direction.
The various stages of planning process is as follows:

1. Identification and definition of problems
2. Defining the objectives
3. Studies and survey
4. Analysis of data and preparation of study maps
5. Fore-casting
6. Design
7. Fixation of priorities
8. Implementation
9. Review, evaluation and feedback

MULTI LEVEL PLANNING IN INDIA

The concept of multi level planning incorporates the principle that proper decision making is possible at any level if the strategy at each level is determined after a careful consideration of the potentials, needs and limitation at the next higher as well as the next lower levels of planning
Multi level planning is two-way approach, requiring many preparatory efforts from both ends. The higher level gives macro framework indicators and guideline for planning. The lower levels must feed the higher level with information and has to prepare from below. The various processes involved in multi-level planning are

- Determination of approach levels of decision making with reference to various activities
- Organizing interaction between different levels in terms of exchange of information and interactive consultations of different stages of plan formulation and appraisal
- 'Nesting of plans' at different levels and integrating them into a unified frame work. Nesting implies securing both the balances within the plans drawn up for different levels and also their harmonization. Securing integration within plans at different levels implies achieving balance at three levels i.e. sectoral, spatial and operational

COMPREHENSIVE COMMUNITY PLANNING

The purpose of community planning is to anticipate the physical environment that will best serve the needs of the people living and working in an urban area, and then to make plans for achieving this environment. It is continuing process of developing a comprehensive programme to guide urban growth and renewal. There are six minimum planning requirements, which are backbone of any programme.

1. *The Land use plan*
2. *The thoroughfare plan*
3. *The community facilities plan*
4. *The public Improvement programme*
5. *The zoning ordinance and map*
6. *The subdivision regulations*

CENTRAL PLACE THEORY by CHRISTELLER Comprehensive approach of the system

Basic elements are

A central good
A central place
A complimentary region

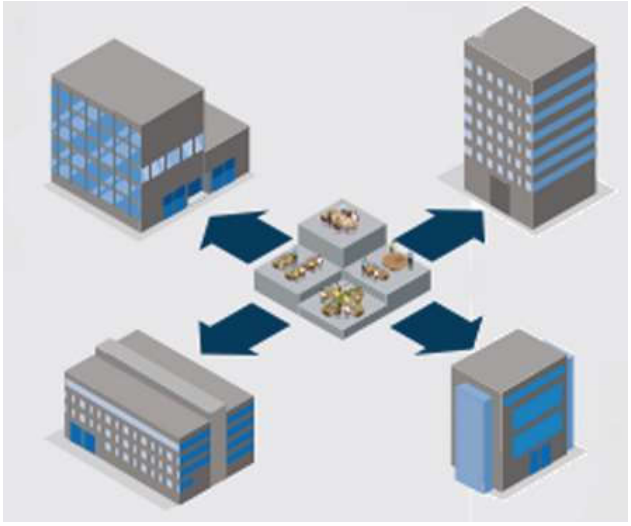
1. A region can be served by goods of various types if central places producing different ranges of goods are evenly distributed

Smart Cities in India

The concept of Smart City to public came after PM Modi had announced his vision to set up 100 smart cities across the country soon after his government was sworn into power mid last year. Since then a race has been on among cities to land on the list that the ministry of urban development is compiling. The 100 smart cities mission intends to promote adoption of smart solutions for efficient use of available assets, reso urces and infrastructure. Following are illustrations show how the concept of smart city has evolved:

(Source: http://timesofindia.indiatimes.com/what -is-a-smart-city-and-how-it-will-work/listshow/47128930.cms)

1..What is a smart city



A city equipped with basic infrastructure to give a decent quality of life, a clean and sustainable environment through application of some smart solutions.

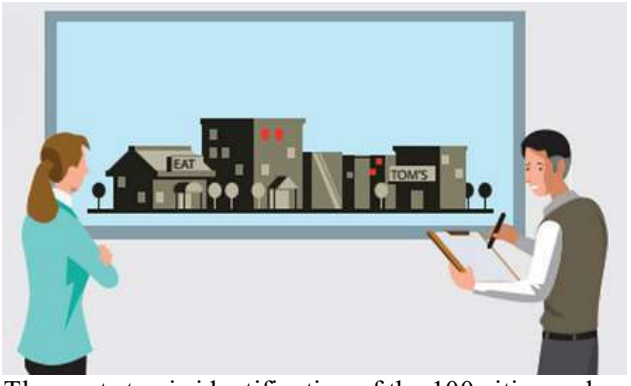
2.. Basic infrastructure

Assured water and electricity supply, sanitation and solid waste management, efficient urban mobility and public transport, robust IT connectivity, e - governance and citizen participation, safety and security of citizens.

3.. Smart solutions

Public information, grievance redressal, electronic service delivery, citizens' engagement, waste to energy & fuel, waste to compost, 100% treatment o f waste water, smart meters & management, monitoring water quality, renewable source of energy, efficient energy and green building, smart parking, intelligent traffic management system.

4.. What's the next step?



The next step is identification of the 100 cities and for this a city challenge competition to be conducted by Bloomberg Philanthropies is envisaged. The current plan looks to select 20 cities this year followed by 40 each in the next two years.

5.. Smart Cities Council India has been formed

It is part of the US-based Smart Cities Council, which is a consortium of smart city practitioners and experts, with a 100-plus member and advisor organizations operating in over 140 countries.

6.. All states will get at least one smart city

A Special Purpose Vehicle will be created for each city to implement Smart City action plan. The SPV will be signed with the urban local body, state government and the Centre for implementation of the project.

7.. How it will work

After government announces the guidelines, states will be asked to nominate names of cities for a 'City Challenge Competition' and the chosen ones will get Central fund of Rs 100 crore each year for 5 years.

8.. The basic criteria for selection of a city/municipal area

9.. Area-based development

1. **Retrofitting 500 acres:** Planning in an existing built-up area in a municipal ward, preparing plan with citiz en participation (example: Connaught Place in Delhi, Bhendi Bazar in Mumbai).
2. **Greenfield 250 acres:** Introduce smart solutions in a vacant area using innovative planning (example: land pooling/land reconstitution in Outer Delhi, GIFT city in Gujarat).
3. **Redevelopement 50 acres:** Replacement of existing built-up area and preparing a new layout plan with enhanced infrastructure by way of mixed land use (example: Kidwai Nagar in Delhi).

Eco City

The term 'eco-cities' is synonymous with urban areas that, at scale, promote environmental preservation. However, decorating cities with boulevards and green buildings, as well as adopting energy - and waste-efficient technologies, are merely small parts of the modern eco-city.

The concept of making cities environmentally sustainable is nothing new. In Europe and the US, the Garden City movement of the 1890s and the post-World War II New Town phenomenon were based on the idea of creating urban areas that merged contemporary and spacious housing with modern infrastructure and greenery. Both were seen as attempts to reinvent the city in the post -industrial era.

The term 'eco-city' surfaced in the 1970s, when a US-based movement known as Urban Ecology first used it. Founded in California, the group launched the journal, The Urban Ecologist. "An eco-city is an ecologically healthy city. That also means the city design is strongly informed by knowledge of ecology and its design principles,"

Image: *One of the principles of eco-cities is a modal shift of private car usage to public transportation. Promoting cycling for short-distance trips can help to encourage that shift.*
Image © Dylan Passmore.

However, many claim the term today depicts a city that adheres to the three core pillars of sustainability: environmental stewardship, social equality and economic prosperity.

Today we know much more about designing and building eco-cities than we did in the 1990s. At that time sustainability was more or less about being environmentally sustainable. Today, however, sustainability is much more recognised and mainstream,"

"We have come to recognise that sustainability has three dimensions: environment and resources; social and cultural cohesion; and economic and financial dimension. We have also realised that we should aim for creating cities for people – cities that are designed and built for the human scale and are vibrant," he adds.

Eco-cities come in all shapes and sizes. Research conducted in 2011 by the International Eco -Cities Initiative claims there are more than 170 such places globally, with this number set to rise over the next decade. Furthermore, the size, scale and types of eco-cities vary widely. In the developing world, for instance, purpose-built eco-cities are being built at breakneck pace, whereas in the West, urban regeneration is more common.

"Greenfield development and retrofitting both have their advantages and disadvantages. In the developed world of Europe, the US and Japan, greenfield is becoming rarer, so in these regions it is more about retrofitting. In the developing world of Asia and Latin America, greenfield development is happening in many places,".

The urbanist names the IBA Hamburg project in Germany and Masdar City in the UAE. It is said that the former exemplifies a hybrid model that mixes retrofitting with building on new land, while the latter demonstrates the ability to build a sustainable city in a harsh desert climate

Drivers of today's eco-cities

It is widely accepted among urbanists that in order to be referred to as an eco-city, cities must embrace the three core pillars of sustainability.

However, behind these principals, a host of other factors influence the modern eco-city. Affordability and demand on the parts of the general public and government policymakers are two notable factors, as are energy -and resource-efficiency and land conservation.

"People want eco-cities only if they can choose freely and can afford to pay for them. Wise politicians and business people listen to their constituents and clientele, and strive to deliver what the people want. As energy prices go up eco-cities will become more competitive. In addition, land scarcity is also driving up prices on building rights, making the densification process unavoidable," .

2. Shopping facilities

Level of shopping	Population served	No. of shops per 1000 persons	Average area per shop in sq.m.	Area of influence in km.
Neighbourhood and convenience centre	3000 - 20,000	3	10 - 15	0.5 - 0.75
Community centre (district level)	50,000 - 75,000	2 - 3	20	1.5 - 3
City centre	1,50,000 & above	3 -4	25	Entire city
Total for the city	Entire city	8 - 10	20	Entire city

3. Parks, playgrounds and open spaces

Category	Population per unit	Area in hectares
Tot - lot	500	0.05
Children's park	2,000	0.2
Neighbourhood playground	1,000	0.2
Neighbourhood park	5,000	0.8
District park	25,000	5.0
Regional park	1,00,000	40.0
Crematorium	5,00,000	0.2
Burial ground	10,000	0.4
Total area required for parks, playgrounds and open spaces	1,000	1.5

4. Water supply consumption

Population range	Break up per capita consumption in litres per day					
	Domestic use	Public use	Ind. and commerce	Agriculture	Waste	Total
Less than 1000	25	---	---	---	---	25
1,000 to 5,000	45	10	5	---	10	70
5,000 to 20,000	45	10	15	15	10	95
20,000 to 50,000	45	35	15	10	10	115
50,000 to 2,00,000	70 - 90	45 -65	20	10	20	165
Above 2,00,000	---	---	---	---	---	165 - 300

5. Desirable land use pattern (percentage)

Particulars	Population range		
	1,50,000 and above	50,000 to 1,50,000	Less than 50,000
Residential	40	45	50
Industrial	8	7	6
Commercial	3.5	3	3
Parks, playgrounds and open spaces	10	10	8
Transportation and communication	24	22	22
Public and semi-public	10	9	8
Others	4.5	4	3
Total	100	100	100

HISTORY & ARCHITECTURE

By
Faculty of Architecture

GATE ARCHITECTURE
2020

gatearchitecture.com

Introduction

This is a part of GATE ARCHITECTURE 2018 complete set. It covers the topic on history & architecture.
The section on history of architecture plays a significant role in scorin g a good marks and so this dedicated section is included. It has three broad topics. Indian history of architecture, world history of architecture & contribution of architects & planners. If you remember of the compilation of Sir Banister Fletcher, you may aware that how vast this topic is itself. Here we have tailored the coverage to the syllabus and questions asked in GATE exams in past years. The topics that are extensively covered through the Question Bank, are escaped here. However, some common topics are discussed here to complement the syllabus.

Contents

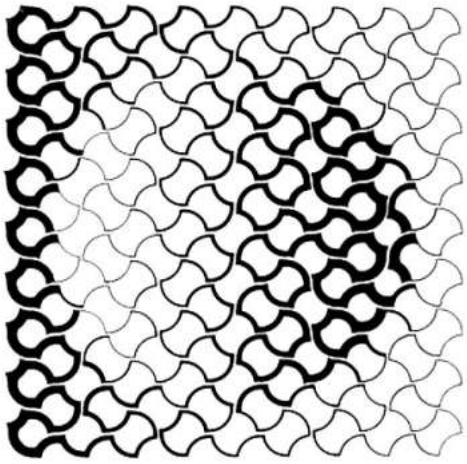
Elements & Principles of Art Design

Elements of design are the parts. They structure and carry the work.
Principles of design are concepts. They affect content and message.

Elements of Design: Line, Form, Space, Texture , Shape, Color , Value
Principles of Design: Emphasis, Movement, Unity, Rhythm, Contrast, Variety

Order and Composition

Composition is the organization of the elements of design into a unified whole. "It is the organization of the whole out of its parts - the conception of single elements, the interrelating of these elements, and the relating of them to the total form. It means 'putting together', and can apply to any work of art, from music to writing to architecture, that is arranged or put together using conscious thought."



It basically refers to the placement or arrangement of conceptual elements (point, line, plane, volume, form, shape, space) and visual elements (color, texture, size and shape) in a work of art according to some (consciously or unconsciously used) compositional principles. "In the visual arts, composition is often used interchangeably with various terms such as design, form, visual ordering, or formal structure, depending on the context."

In architectural design, the architect creates an ordered expression through the process of composition by using the raw materials of architectural form, which are basically the mass and the space. In this process, the material forms (masses) and spaces are arranged into the final composition, of the definitiv e design. At this stage each element ends up in its proper place according to the principles of composition. Without this ordering process the result would be chaos. The method of ordering and the concept employed ultimately dictate the character, appearance and style of a design."

Frank Lloyd Wright, Johnson and Wax Building

Some compositional principles might be used (such as unity, balance, hierarchy, scale, dominance, similarity, contrast, rhythm, repetition, symmetry) to create this order. The way the formal and spatial elements are arranged th rough these principles creates the order of composition in architecture.

These organizational principles of composition are like the grammar of a language. The use of these principles over the visual and conceptual elements of design is like using a visual grammar. It is like speaking and writing in the language of architectural design. Visual and conceptual elements are the materials (words) of design and the principles are the ways to work with and arrange the elements (grammar). However it is also true that there is not such a thing that these principles should be obeyed.

Principles of visual composition

1. Important factor to be considered in Urban Design – Arrangement of spaces
   Good composition
   Orderly and pleasing
   Pleasure follows order
2. principles of composition –

Unity –

- Oneness and brings harmony with the surroundings.
- Similar forms give coherence to the parts and integrity to the whole.
- An urban form so planned and created will create a single picture of unity.
- Dissimilar forms, texture, color lack unity.

Segregation –

- Composition should form an independent unit by separating from others by enclosing masses.
- It can be made up neutral forms, average textures or subdued colors of building masses.

Coherence –

- Complicated compositions lack coherence.
- Too many sorts of buildings, elements, and accessories result in lack of coherence.

Balance –

- **Symmetrical balance – Balance** means equality and it can be easily obtained by symmetrical type of plants or features on either side of the central axis of composition. Balance should be dynamic, vital hence it should be rhythmic.
- **Asymmetrical or Occult balance –** Too unequal masses on either side of the central axis form asymmetrical balance. Meticulously arranged occult balance adds softness and freedom to the composition.

Scale –

- The building or group of buildings must be in scale with its surroundings.
- The parts of the composition in relation to each other should exhibit their true size.

Rhythm and reputation –

- It is a devise to give continuity to the design.
- It develops rhythmic sequence producing a coherent effect.
- Use distinctive elements for a rhythmic arrangement (columns, openings like windows), to hold together and carry the eye from part to the other.

Color –

- Select paints for long color effects.
- A feeling of coherence in design is achieved by color as well or by simple repetition of the same color at regular intervals.

Texture –

- It is the surface quality which give a textile sensation when touched, such as soft cum hard, smooth, rough etc.,
- Sandstone – course.
- Marble – translucent and soft

Light and Shade –

- Occasional Shades cast by large openings produce a pictorial effect.
- Columns and arcades throw shadows in the morning and evening producing a constant change of light and shade.
- Quality of color also changes according to the intensity of light.

3. Visual aspect of plan arrangement –
   - View: is a scene observed from a given place.
   - Vista: is a confined view to a dominant feature. Each vista has a viewing station. A well conceived vista has the balance and rhythm.
   - Axis: is a linear element connecting two or more elements such as a drive, a street or a park way. It is directional, orderly, dominating.

4. Color theory –

Primary hues - RED, YELLOW, BLUE
Complementary colors: Red and Green
Harmonizing colors – hues adjacent on the color wheel.
Hue – (first dimension), by definition it is pure color, containing no white, black or grey.

Timeline: Indian History of Architecture

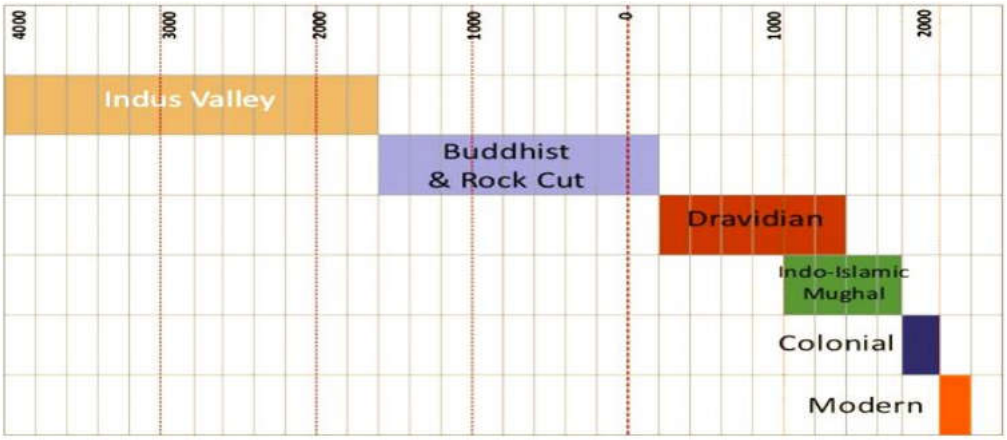


Figure: Architecture timeline

Indus Valley Civilization

Introduction

- A bronze age civilization- Also known as harappan civilization (2600-1900 BC)
- Thrived in the basins of Indus river profiting from the fertility of the land
- Had a population of 5 million at its peak
- People were mostly tradesmen or artisans
- Known for
  - futuristic urban planning
  - astonishing architecture
  - remarkable handicrafts
  - work in the field of metallurgy

Figure: Excavations at Mohenjo-Daro

Regional Spread

Figure: Spread of Indus Valley Civilization

- Sites cover most of the modern Pakistan and northwestern India
- Area covered is about 1.3 million square miles
- The largest among the old world civilizations
- Over 1050 sites; scattered across the area.

Architecture

- The cities are build on numerous mounds (elevated grounds)
- Advanced architecture
  - Impressive dockyards
  - Graineries
  - Warehouses
- Walled city (protection from flood water)
- Well planned streets
- Proper sanitation and drainage system
- Baked brick houses

Figure: The drain

Mahabodhi Temple, Bodh Gaya, Bihar

Figure: Mahabodhi Temple, Bodh Gaya.

The magnificient **Maha Bodhi temple** in Bodhgaya is an architectural amalgamation of many cultures. Originally believed to be small shrine erected by Emperor Asoka in the 3rd century B.C, temple was later restored in the 11th and 18th centuries. The temple bears the stamp of the architecture of the Gupta Dynasty and subsequent ages. On the walls of the temple, one sees Buddha carved in different aspects, and in the sanctum sanctorum, a colossal Buddha, is seen touching the ground, which has mythological significance in the Buddhist lores. The temple has a 54 meters high pyramidical spire and an ornamental arch way at the entrance. The temple carries inscriptions recording the visits of pilgrims from Sri Lanka, China and Mayanmar in the 7th and 10th Centuries A.D. Hieun Tsang, the Chinese traveller, also visited the temple in the 7th Century.

The Mahabodhi temple has a 150 feet high tower, and it contains a gilded image of Buddha. The original shrine here is believed to have been raised by Emperor Ashoka. The temple has a beautiful stone railing around it. Depicted on the walls of the temple are scenes from Buddha's life. A museum in the vicinity has gold, bronze and stone images of Buddha.

Figure: Mahabodhi Temple Inside Picture

The Vajrasana-platform where Buddha performed his penance is located below the Bodhi tree, and this spot is described as the center of the Universe. The spots where he spent seven weeks have seven shrines, built by devout Buddhists from several countries.

Several Buddhist relics have been unearthed in this area. Other places of interest here include the Tibetian, Japanese and Burmese monasteries. The Tibetian monastery houses the massive Dharma Chakra or the wheel of law. Millions visit Buddha Gaya from all over the world.

The basement of the present temple is 15m square, 15m in length as well as in breadth and its height is 52m which rises in the form of a slender pyramid tapering off from a square platform. On its four corners four towers gracefully rise to some height. The whole architectural plan gives pose and balance to the observers.

Inside the temple there is a colossal image of the Buddha in the "touching the ground pose", bhumisparsha mudra. This image is said to be 1700 years old and is facing east exactly at the place where the Buddha in meditation with his back to the Bodhi tree was enlightened.

Figure: The Bodhi Tree of Mahabodhi Temple

Bodhi Tree

The original **'Bodhi tree'** or Pipal (Ficus religiosa) - the tree of awakening; was said to have been destroyed by Mauryan emperor

Modern Architecture In India

No doubt we have a great architectural heritage of temples, mosques, palaces and forts. So much so that whenever architecture is thought of in conjunction with India, images of the Taj Mahal, Fatehpur Sikri and South Indian temples are conjured up in our minds.

Do we have anything today as representative of Modern Architecture which could be compared with our old buildings? Or in even simpler terms - 'what represents Modern Architecture in India'?

The question which is difficult to answer - demands more than skin deep analysis of modern architecture in the context of India.

The answer to this question also depends on the spirit behind it. If the curiosity behind the question concerns the quantum of construction done in post-independence years, the answer can be one impressive list of statistical figures, a fine achievement for building science and technology.

But, if on the other hand the questioning mind is concerned about new architectural and planning thought generated in the same post-independence years, which have resulted in buildings and cities suited to our socio-economic, cultural and climatical circumstances, our achievements are not very impressive so far. But considering the fact that formation of thoughts and ideas, in this relatively young field, has been going for only the last quarter of century and with the limited resources that we have, it is evident that we are on the verge of making a break -through.

Figure: **Chhatrapati Shivaji Terminus, formerly Victoria Terminus, is a UNESCO World Heritage Site and historic railway station which serves as the headquarters of the Central Railways in Mumbai.**

It is not out of context here to go into details how things have been happening in the field of architecture in years preceeding the following independence.

Architecture traditionally, i.e., before the arrival of British on the Indian soil, was from the social point of view, a creation of spectacular sculptural forms hewn out of stone. Architectural material was stone; tools, chisel and hammer, and the aim was glorification. In contrast, the every-day needs of a common man were ruthlessly neglected. Then the British arrived on the scene, it was through them that the first introduction to elementary modern building construction and planning was introduced into India. Their aim, however, was to house their organisations, and their people and whatever was necessary to control an empire as big as India. Apart from self-serving military cantonments and civil lines, they also left the basic problems well alone. It was no intention of the British to educate Indians in the art and science of architecture. Consequently Indian minds, during the British reign, were completely out of touch with the progressive thinking taking place in the rest of the world. The most significant architectural phenomenon that took place during the first half of this century in this country was building of Imperial Delhi. This was an anachronism of the highest order, because, while at that time contemporary Europeans were engaged in most progressive thinking in architecture, Sir Edward Lutyen's was a masterpiece in high renaissance architecture, the result of a way of thinking typical of the early nineteenth century in Europe. It is interesting to note that at the same time as the construction of Delhi, Europe was having "Heroic period of modern architecture" in such schools of thought as "Bauhaus".

Independence woke us to a changed situation. "Time had moved on. In place of religion or royal concern with architectural immortality, this situation demanded attention to those problems that had so far been ruthlessly neglected. The ordinary man, his environment and needs became the centre of attention. Demand for low cost housing became urgent.

URBAN PLANNING & DESIGN

GATE ARCHITECTURE 2020

By
Faculty of Architecture

gatearchitecture.com

Introduction

One of major reasons to score low in GATE exam for B.Arch students is that few are fully aware that GATE AR is for both of B.Arch & B.Plan. So, a quite well n umber of questions would be asked in exam covering B. Planning section.

This is a reason you have this booklet. Please note that we have covered in depth the section about town planners, theories and their contribution in Question-Bank itself. Therefore we have minimized those sections here.

Urban planning and design more of theories, stories, concepts etc. We have randomly selected topics from the syllabus and put into concise and bullet form as far as possible.

You should read this booklet as a complementary to the complete set.

GATE SYLLABUS 2018 [Contents covered in this section are highlighted]

Section 5: Urban Design Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

Section 6: Urban Planning and Housing Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.

City Planning

Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.

Urban Design

What is urban design?

Unfortunately, there are no hard and fast rules related to urban design. A structural beam in a building must meet certain requirements for that building to stand. A road must be built in a certain way to avoid future potholes.

Urban design, however, is not a series of rules and standards. Rather, it is a group of concepts that, once understood, can lead to a fresh way of perceiving streets, buildings, and spaces -- and insights into why certain places are appealing and others are not. With urban design concepts in mind you should be able to better question architectural presentations and consider the impact of development proposals on your town's character.

Introduction to urban design

When walking down the street you see a place that appears interesting and inviting. Across the street you glance at another area but it looks unappealing and uncomfortable. Which place would you rather be? That's easy to answer. The more difficult question is: Why? What is it that creates a place that people like and use? Understanding some of the ideas of urban design can help us better answer this question. Urban design does not have to be a mystery. Knowing a few important concepts can make it easier for you to observe what works – and what doesn't – as you stroll through your town, or as you review a project application.

Urban design is concerned with the arrangement, appearance and function of our suburbs, towns and cities. It is both a process and an outcome of creating localities in which people live, engage with each other, and engage with the physical place around them.

Urban design involves many different disciplines including planning, development, architecture, landscape architecture, engineering, economics, law and finance, among others.

We can also say, Urban design is the art of making places for people. It includes the way places work and matters such as community safety, as well as how they look. It concerns the connections between people and places, movement and urban form, nature and the built fabric, and the processes for ensuring successful villages, towns and cities.

Urban design operates at many scales, from the macro scale of the urban structure (planning, zoning, transport and infrastructure networks) to the micro scale of street furniture and lighting. When fully integrated into policy and planning systems, urban design can be used to inform land use planning, infrastructure, built form and even the socio - demographic mix of a place.

	Architecture	**Urban Design**	**Urban Planning**
Scale	Individual building	Space between buildings: Street, park, transit shop	Whole neighborhood, districts & cities
Orientation	Aesthetic and functional	Aesthetic and functional	Unity
Treatment of space	2D & 3D	3D	Predominantly 2D
Time frame	No definite time frame	Short Term (< 5 years)	Long term (5 to 20 years)

Concepts of urban design

Key urban design concepts are:

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

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

Physical Comfort

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

Circulation and Accessibility

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

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

Transitions and Boundaries

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

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

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

PLANNING PROCESS:

All stages of actions from defining the objectives till implementation and review of any planning project in the planning process. In plan preparation, the physical planning should associate with the socio-economical, geographical, political factors, for achieving the objective in desired direction.
The various stages of planning process is as follows:

1. Identification and definition of problems
2. Defining the objectives
3. Studies and survey
4. Analysis of data and preparation of study maps
5. Fore-casting
6. Design
7. Fixation of priorities
8. Implementation
9. Review, evaluation and feedback

MULTI LEVEL PLANNING IN INDIA

The concept of multi level planning incorporates the principle that proper decision making is possible at any level if the strategy at each level is determined after a careful consideration of the potentials, needs and limitation at the next higher as well as the next lower levels of planning
Multi level planning is two-way approach, requiring many preparatory efforts from both ends. The higher level gives macro framework indicators and guideline for planning. The lower levels must feed the higher level with information and has to prepare from below. The various processes involved in multi-level planning are

- Determination of approach levels of decision making with reference to various activities
- Organizing interaction between different levels in terms of exchange of information and interactive consultations of different stages of plan formulation and appraisal
- 'Nesting of plans' at different levels and integrating them into a unified frame work. Nesting implies securing both the balances within the plans drawn up for different levels and also their harmonization. Securing integration within plans at different levels implies achieving balance at three levels i.e. sectoral, spatial and operational

COMPREHENSIVE COMMUNITY PLANNING

The purpose of community planning is to anticipate the physical environment that will best serve the needs of the people living and working in an urban area, and then to make plans for achieving this environment. It is continuing process of developing a comprehensive programme to guide urban growth and renewal. There are six minimum planning requirements, which are backbone of any programme.

1. *The Land use plan*
2. *The thoroughfare plan*
3. *The community facilities plan*
4. *The public Improvement programme*
5. *The zoning ordinance and map*
6. *The subdivision regulations*

CENTRAL PLACE THEORY by CHRISTELLER Comprehensive approach of the system

Basic elements are

A central good
A central place
A complimentary region

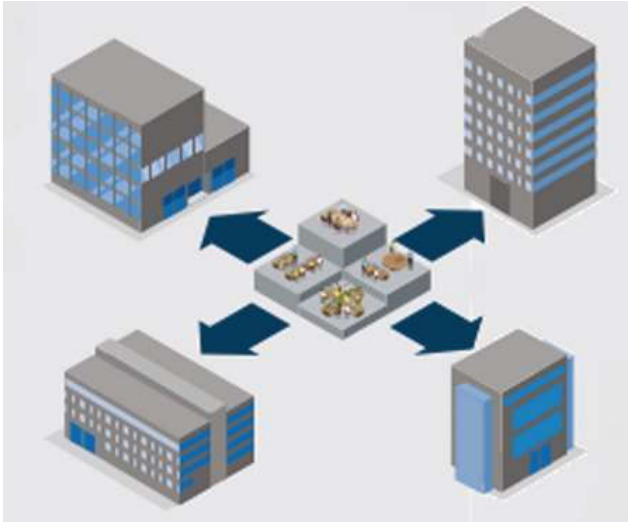
1. A region can be served by goods of various types if central places producing different ranges of goods are evenly distributed

Smart Cities in India

The concept of Smart City to public came after PM Modi had announced his vision to set up 100 smart cities across the country soon after his government was sworn into power mid last year. Since then a race has been on among cities to land on the list that the ministry of urban development is compiling. The 100 smart cities mission intends to promote adoption of smart solutions for efficient use of available assets, reso urces and infrastructure. Following are illustrations show how the concept of smart city has evolved:

(Source: http://timesofindia.indiatimes.com/what -is-a-smart-city-and-how-it-will-work/listshow/47128930.cms)

1..What is a smart city



A city equipped with basic infrastructure to give a decent quality of life, a clean and sustainable environment through application of some smart solutions.

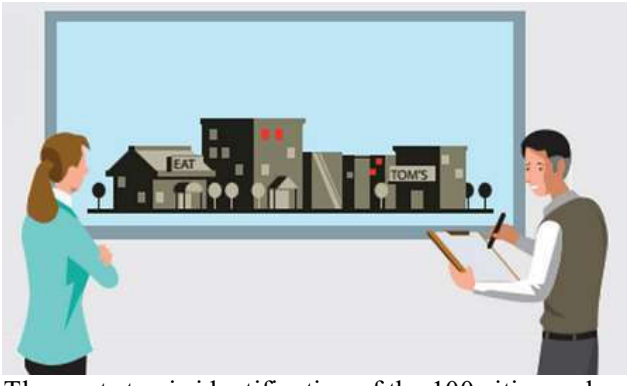
2.. Basic infrastructure

Assured water and electricity supply, sanitation and solid waste management, efficient urban mobility and public transport, robust IT connectivity, e - governance and citizen participation, safety and security of citizens.

3.. Smart solutions

Public information, grievance redressal, electronic service delivery, citizens' engagement, waste to energy & fuel, waste to compost, 100% treatment o f waste water, smart meters & management, monitoring water quality, renewable source of energy, efficient energy and green building, smart parking, intelligent traffic management system.

4.. What's the next step?



The next step is identification of the 100 cities and for this a city challenge competition to be conducted by Bloomberg Philanthropies is envisaged. The current plan looks to select 20 cities this year followed by 40 each in the next two years.

5.. Smart Cities Council India has been formed

It is part of the US-based Smart Cities Council, which is a consortium of smart city practitioners and experts, with a 100-plus member and advisor organizations operating in over 140 countries.

6.. All states will get at least one smart city

A Special Purpose Vehicle will be created for each city to implement Smart City action plan. The SPV will be signed with the urban local body, state government and the Centre for implementation of the project.

7.. How it will work

After government announces the guidelines, states will be asked to nominate names of cities for a 'City Challenge Competition' and the chosen ones will get Central fund of Rs 100 crore each year for 5 years.

8.. The basic criteria for selection of a city/municipal area

9.. Area-based development

1. **Retrofitting 500 acres:** Planning in an existing built-up area in a municipal ward, preparing plan with citiz en participation (example: Connaught Place in Delhi, Bhendi Bazar in Mumbai).
2. **Greenfield 250 acres:** Introduce smart solutions in a vacant area using innovative planning (example: land pooling/land reconstitution in Outer Delhi, GIFT city in Gujarat).
3. **Redevelopement 50 acres:** Replacement of existing built-up area and preparing a new layout plan with enhanced infrastructure by way of mixed land use (example: Kidwai Nagar in Delhi).

Eco City

The term 'eco-cities' is synonymous with urban areas that, at scale, promote environmental preservation. However, decorating cities with boulevards and green buildings, as well as adopting energy - and waste-efficient technologies, are merely small parts of the modern eco-city.

The concept of making cities environmentally sustainable is nothing new. In Europe and the US, the Garden City movement of the 1890s and the post-World War II New Town phenomenon were based on the idea of creating urban areas that merged contemporary and spacious housing with modern infrastructure and greenery. Both were seen as attempts to reinvent the city in the post -industrial era.

The term 'eco-city' surfaced in the 1970s, when a US-based movement known as Urban Ecology first used it. Founded in California, the group launched the journal, The Urban Ecologist. "An eco-city is an ecologically healthy city. That also means the city design is strongly informed by knowledge of ecology and its design principles,"

Image: *One of the principles of eco-cities is a modal shift of private car usage to public transportation. Promoting cycling for short-distance trips can help to encourage that shift.*
Image © Dylan Passmore.

However, many claim the term today depicts a city that adheres to the three core pillars of sustainability: environmental stewardship, social equality and economic prosperity.

Today we know much more about designing and building eco-cities than we did in the 1990s. At that time sustainability was more or less about being environmentally sustainable. Today, however, sustainability is much more recognised and mainstream,"

"We have come to recognise that sustainability has three dimensions: environment and resources; social and cultural cohesion; and economic and financial dimension. We have also realised that we should aim for creating cities for people – cities that are designed and built for the human scale and are vibrant," he adds.

Eco-cities come in all shapes and sizes. Research conducted in 2011 by the International Eco -Cities Initiative claims there are more than 170 such places globally, with this number set to rise over the next decade. Furthermore, the size, scale and types of eco-cities vary widely. In the developing world, for instance, purpose-built eco-cities are being built at breakneck pace, whereas in the West, urban regeneration is more common.

"Greenfield development and retrofitting both have their advantages and disadvantages. In the developed world of Europe, the US and Japan, greenfield is becoming rarer, so in these regions it is more about retrofitting. In the developing world of Asia and Latin America, greenfield development is happening in many places,".

The urbanist names the IBA Hamburg project in Germany and Masdar City in the UAE. It is said that the former exemplifies a hybrid model that mixes retrofitting with building on new land, while the latter demonstrates the ability to build a sustainable city in a harsh desert climate

Drivers of today's eco-cities

It is widely accepted among urbanists that in order to be referred to as an eco-city, cities must embrace the three core pillars of sustainability.

However, behind these principals, a host of other factors influence the modern eco-city. Affordability and demand on the parts of the general public and government policymakers are two notable factors, as are energy -and resource-efficiency and land conservation.

"People want eco-cities only if they can choose freely and can afford to pay for them. Wise politicians and business people listen to their constituents and clientele, and strive to deliver what the people want. As energy prices go up eco-cities will become more competitive. In addition, land scarcity is also driving up prices on building rights, making the densification process unavoidable," .

2. Shopping facilities

Level of shopping	Population served	No. of shops per 1000 persons	Average area per shop in sq.m.	Area of influence in km.
Neighbourhood and convenience centre	3000 - 20,000	3	10 - 15	0.5 - 0.75
Community centre (district level)	50,000 - 75,000	2 - 3	20	1.5 - 3
City centre	1,50,000 & above	3 -4	25	Entire city
Total for the city	Entire city	8 - 10	20	Entire city

3. Parks, playgrounds and open spaces

Category	Population per unit	Area in hectares
Tot - lot	500	0.05
Children's park	2,000	0.2
Neighbourhood playground	1,000	0.2
Neighbourhood park	5,000	0.8
District park	25,000	5.0
Regional park	1,00,000	40.0
Crematorium	5,00,000	0.2
Burial ground	10,000	0.4
Total area required for parks, playgrounds and open spaces	1,000	1.5

4. Water supply consumption

Population range	Break up per capita consumption in litres per day					
	Domestic use	Public use	Ind. and commerce	Agriculture	Waste	Total
Less than 1000	25	---	---	---	---	25
1,000 to 5,000	45	10	5	---	10	70
5,000 to 20,000	45	10	15	15	10	95
20,000 to 50,000	45	35	15	10	10	115
50,000 to 2,00,000	70 - 90	45 -65	20	10	20	165
Above 2,00,000	---	---	---	---	---	165 - 300

5. Desirable land use pattern (percentage)

Particulars	Population range		
	1,50,000 and above	50,000 to 1,50,000	Less than 50,000
Residential	40	45	50
Industrial	8	7	6
Commercial	3.5	3	3
Parks, playgrounds and open spaces	10	10	8
Transportation and communication	24	22	22
Public and semi-public	10	9	8
Others	4.5	4	3
Total	100	100	100

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