SSC-JE 2021

STAFF SELECTION COMMISSION
[JUNIOR ENGINEER]

PRELIMINARY EXAMINATION

CIVIL ENGINEERING

PREVIOUS YEARS TOPICWISE OBJECTIVE
DETAILED SOLUTION WITH THEORY

2004-2019

IES MASTER PUBLICATION

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PREFACE

There is no better way to get into SSC-JE in an effortless manner than to get into the minds of the examiner/ commission. And, the route to it is reverse engineering the previous years' questions while understanding the psychological requirements of learning. What if, in doing so, you not only memorise but also acquire the ability to project upon the probabilities of the upcoming exam.

As you dive into the revised and updated edition of the book '**IES Master Previous Year Topic-wise Objective Detailed Solutions with Theory**' carrying **40** previous years question paper sets, you will start feeling the pulse of the exam whereby which in turn will help you to develop the feel of subjects. The previous years' questions decoded in a Question-Answer format not only give you ample amount of relevant theory, but an extra theory along with reasoning for other given options.

So, what might appear to other students as disorder, randomness, and wide coverage, becomes order for you as you work through topic-wise solutions. While delving into the knowledge base, the numbers dance to your fingers, and the weights assigned to the subjects fit in like a jigsaw puzzle. From here on, you know what to read, where to read, and how to read.

This masterpiece from IES Master's Research & Development team ensures that your level of preparedness matches exactly to that required in the actual SSC-JE exam. Thus far, and no further, the book leaves no stone unturned in its easy-to-understand language, optimized with fonts and layout that your eyes will surely relish.

IES MASTER PUBLICATION
NEW DELHI

HOW TO GET THE MOST OUT OF THIS BOOK

To get the most out of any book in the most effortless and effective manner, one needs to move ahead in a strategic manner rather than just wrestling with the content. How a book is read is the biggest determining factor in getting the most out of any book. Therefore, to help the readers of this book understand its value, we are going to present hereby a multi-step process that needs to be followed.

Before going into the details about the process, first of all let us understand the structure of this book's content. The book includes questions from previous year SSC-JE question papers. The questions are arranged in a topic-wise manner, and each question has a detailed solution followed by a crux theory related to that particular question's topic. A good amount of research has gone into preparing this crux theory as previous years' question papers of SSC-JE, State PSCs, and other engineering exams have been comprehensively analysed in a topic-wise manner. The crux theory has been prepared in such a comprehensive manner that the probability of questions coming in the forthcoming SSC-JE, State PSCs or other engineering exams from that particular topic becomes very high.

Now let's see how the worth of reading this book can be realised in an effective manner. To start with, one need to read in one go any particular topic-related question, its detailed solution, and the related crux theory. Memorise the crux theory of that topic before jumping on to the next topic question. As the questions in the book have been arranged in a topic-wise manner, memorising the theory along with detailed solution will facilitate covering any particular topic in the most efficient as well as effective manner.

Thus, by reading this book in such a selective and targeted manner, one will cover the entire exam syllabus well before time leaving no stone unturned.

Our main objective behind bringing out this book is that you as a reader benefit the most from reading it. Hope by implementing the above-discussed strategy, you achieve success in fulfilling your dream of clearing SSC-JE, State PSCs or other engineering exams.

All the best!!!

EXAM PATTERN

PAPERS	MODE OF EXAMINATION	SUBJECT	NUMBER OF QUESTIONS	MAXIMUM MARKS	DURATION & TIMINGS
Paper-I Objective Type	Computer Base Mode	(i) General Intelligence Reasoning	50	50	2 Hours
		(ii) General Awareness	50	50	Morning Shift
		(iii) General Engineering (Civil and Structural)	100	100	Evening Shift
Paper-II Conventional Type	Written Examination	General Engineering (Civil and Structural)		300	2 Hours

SYLLABUS

PAPER-I

General Intelligence & Reasoning

The Syllabus for General Intelligence would include questions of both verbal and non-verbal type. The test may include questions on analogies, similarities, differences, space visualization, problem solving, analysis, judgement, decision making, visual memory, discrimination, observation, relationship concepts, arithmetical reasoning, verbal and figure classification, arithmetical number series etc. The test will also include questions designed to test the candidate's abilities to deal with abstract ideas and symbols and their relationships, arithmetical computations and other analytical functions.

General Awareness

Questions will be aimed at testing the candidate's general awareness of the environment around him/her and its application to society. Questions will also be designed to test knowledge of current events and of such matters of everyday observations and experience in their scientific aspect as may be expected of any educated person. The test will also include questions relating to India and its neighbouring countries especially pertaining to History, Culture, Geography, Economic Scene, General Polity and Scientific Research, etc. These questions will be such that they do not require a special study of any discipline.

General Engineering

Civil and Structural

Theory of Structures, RCC Design, Steel Design, Building Materials and Concrete Technology, Estimating, Costing and Valuation, Environmental Engineering, Soil Mechanics, Hydraulics, Irrigation Engineering, Transportation Engineering and Surveying.

PAPER-II

Structural Engineering : Theory of structures: Elasticity constants, types of beams – determinate and indeterminate, bending moment and shear force diagrams of simply supported, cantilever and over hanging beams. Moment of area and moment of inertia for rectangular & circular sections, bending moment and shear stress for tee, channel and compound sections, chimneys, dams and retaining walls, eccentric loads, slope deflection of simply supported and cantilever beams, critical load and columns, Torsion of circular section.

RCC Design : RCC beams-flexural strength, shear strength, bond strength, design of singly reinforced and double reinforced beams, cantilever beams. T-beams, lintels. One way and two way slabs, isolated footings. Reinforced brick works, columns, staircases, retaining wall, water tanks (RCC design questions may be based on both Limit State and Working Stress methods).

Steel Design : Steel design and construction of steel columns, beams roof trusses plate girders.

Building Materials : Physical and Chemical properties, classification, standard tests, uses and manufacture / quarrying of materials e.g. building stones, silicate based materials, cement (Portland), asbestos products, timber and wood based products, laminates, bituminous materials, paints, varnishes.

Concrete Technology : Properties, Advantages and uses of concrete, cement aggregates, importance of water quality, water cement ratio, workability, mix design, storage, batching, mixing, placement, compaction, finishing and curing of concrete, quality control of concrete, hot weather and cold weather concreting, repair and maintenance of concrete structures.

Estimating, Costing and Valuation : Estimate, glossary of technical terms, analysis of rates, methods and unit of measurement, items of work – earthwork, Brick work (Modular & Traditional bricks), RCC work, Shuttering, Timber work, Painting, Flooring, Plastering, Boundary wall, Brick building, Water Tank, Septic Tank, Bar bending schedule, Centre line method, Mid-section formula, Trapezodial formula, Simpson's rule. Cost estimate of Septic tank, flexible pavements, Tube well, isolates and combined footings, Steel Truss, Piles and pilecaps. Valuation – Value and cost, scrap value, salvage value, assessed value, sinking fund, depreciation and obsolescence, methods of valuation.

Environmental Engineering : Quality of water, source of water supply, purification of water, distribution of water, need of sanitation, sewerage systems, circular sewer, oval sewer, sewer appurtenances, sewage treatments. Surface water drainage. Solid waste management – types, effects, engineered management system. Air pollution – pollutants, causes, effects, control. Noise pollution – cause, health effects, control.

Soil Mechanics : Origin of soil, phase diagram, Definitions-void ratio, porosity, degree of saturation, water content, specific gravity of soil grains, unit weights, density index and interrelationship of different parameters. Grain size distribution curves and their uses. Index properties of soils, Atterberg's limits, ISI soil classification and plasticity chart. Permeability of soil, coefficient of permeability, determination of coefficient of permeability, Unconfined and confined aquifers, effective stress, quick sand, consolidation of soils, Principles of consolidation, degree of consolidation, pre-consolidation pressure, normally consolidated soil, e-log p curve, computation of ultimate settlement. Shear strength of soils, direct shear test, Vane shear test, Triaxial test. Soil compaction, Laboratory compaction test, Maximum dry density and optimum moisture content, earth pressure theories, active and passive earth pressures, Bearing capacity of soils, plate load test, standard penetration test.

Hydraulics : Fluid properties, hydrostatics, measurements of flow, Bernoulli's theorem and its application, flow through pipes, flow in open channels, weirs, flumes, spillways, pumps and turbines.

Irrigation Engineering : Definition, necessity, benefits, ill effects of irrigation, types and methods of irrigation, Hydrology – Measurement of rainfall, run off coefficient, rain gauge, losses from precipitation – evaporation, infiltration, etc. Water requirement of crops, duty, delta and base period, Kharif and Rabi Crops, Command area, Time factor, Crop ratio, Overlap allowance, Irrigation efficiencies. Different type of canals, types of canal irrigation, loss of water in canals. Canal lining – types and advantages. Shallow and deep to wells, yield from a well. Weir and barrage, Failure of weirs and permeable foundation, Slit and Scour, Kennedy's theory of critical velocity. Lacey's theory of uniform flow. Definition of flood, causes and effects, methods of flood control, water logging, preventive measure. Land reclamation, Characteristics of affecting fertility of soils, purposes, methods, description of land and reclamation processes. Major irrigation projects in India.

Transportation Engineering : Highway Engineering – cross sectional elements, geometric design, types of pavements, pavement materials – aggregates and bitumen, different tests, Design of flexible and rigid pavements – Water Bound Macadam (WBM) and Wet Mix Macadam (WMM), Gravel Road, Bituminous construction, Rigid pavement joint, pavement maintenance, Highway drainage.

Railway Engineering : Components of permanent way – sleepers, ballast, fixtures and fastening, track geometry, points and crossings, track junction, stations and yards. Traffic Engineering – Different traffic survey, speed-flow-density and their inter-relationships, intersections and interchanges, traffic signals, traffic operation, traffic signs and markings, road safety.

Surveying : Principles of surveying, measurement of distance, chain surveying, working of prismatic compass, compass traversing, bearings, local attraction, plane table surveying, theodolite traversing, adjustment of theodolite, Levelling. Definition of terms used in levelling, contouring, curvature and refraction corrections, temporary and permanent adjustments of dumpy level, methods of contouring, uses of contour map, tachometric survey, curve setting, earth work calculation, advanced surveying equipment.

ANALYSIS OF PREVIOUS YEARS QUESTIONS IN PERCENTAGE (%)															
SUBJECT/YEAR	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
THEORY OF STRUCTURE	08	19	04	14	12	10	13	24	24	12	12	16	13	07	35
RCC DESIGN	08	12	25	10	18	15	12	10	12	08	11	11	11	10	45
STEEL DESIGN	09	10	14	11	09	12	10	11	04	10	13	07	06	06	26
BUILDING MATERIALS AND CONCRETE TECHNOLOGY	26	15	18	27	24	23	22	18	19	30	25	27	25	14	73
ESTIMATING, COSTING AND VALUATION	00	00	00	00	00	00	04	06	05	08	06	07	08	10	55
ENVIRONMENTAL ENGINEERING	13	12	13	08	07	08	06	04	05	03	03	03	02	08	41
SOIL MECHANICS	13	15	10	12	13	12	09	05	04	04	05	04	05	08	40
HYDRAULICS	14	10	10	09	08	10	07	09	10	11	10	10	15	09	46
IRRIGATION ENGINEERING	00	00	00	00	00	00	04	01	02	02	02	02	02	09	45
TRANSPORTATION ENGINEERING	00	00	02	00	01	02	07	02	03	02	04	03	03	07	43
SURVEYING	09	07	04	09	08	08	06	10	12	10	09	10	10	09	51

CONTENT

1 STRENGTH OF MATERIALS

2004

1. Limiting values of Poisson's ratio are :

(a) –1 and 0.5 **(b) –1 and –0.5**

(c) 1 and –0.5 **(d) 0 and 0.5**

Sol–(d)

The ratio of lateral strain to longitudinal strain is known as poisson's ratio (μ).

$$\mu = -\frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

For engineering materials, ***the value of poisson's ratio range between 0 to 0.5.***

Material	Poisson's ratio (μ)
Cork	0
Concrete	0.1 – 0.2
Aluminium	0.33
Cast iron	0.2 – 0.3
Steel	0.27 – 0.3
Perfectly elastic rubber	0.5

Note: Generally for metal such as (Steel, Copper, Aluminium etc.) the poisson's ratio value in the range of 0.25 to 0.40.

2. Proof resilience is the maximum energy stored at:

(a) Limit of proportionality

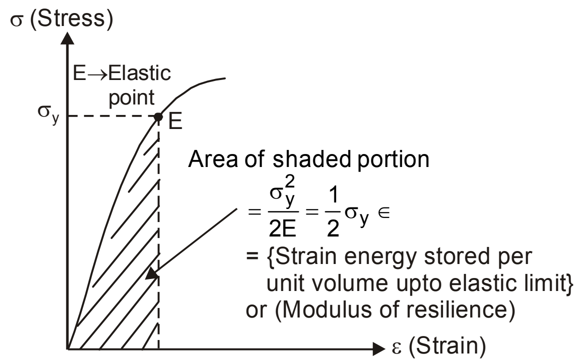
(b) Elastic limit

(c) Plastic limit

(d) None of these

Sol–(b)

Proof resilience is defined as the maximum energy that can be absorbed up to the elastic limit, without creating a permanent distortion.



Proof resilience = Modulus of resilience × Volume

3. The specimen in a Charpy impact test is supported as a :

(a) Cantilever beam

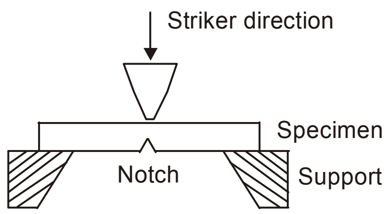
(b) Simply supported beam

(c) Fixed beam

(d) Continuous beam

Sol–(b)

The Charpy impact test measures the energy absorbed by a standard notched specimen while breaking under an impact load. The Charpy impact test continues to be used as an economical quality control method to determine the notch sensitivity and impact toughness of engineering materials.



Note: There is another method that also measures the impact resistance of any material; ***Izod impact test.*** This is different from charpy test.

- In ***Izod test*** the ***specimen is supported as cantilever beam while in charpy test it is supported as simply supported beam***.
- Notch face in Izod test is facing the striker while in charpy test, the notch face is positioned away from the striker.
- ***In Izod test,*** only ***V-notch is used*** while in ***charpy test both V-notch and U-notch*** can be used.

2005

4. The limit of Poisson's ratio is :

(a) 0.25 **(b) 0.15**

(c) 0.50 **(d) 0.65**

Sol–(c)

The ratio of lateral strain to longitudinal strain is known as poisson's ratio (μ).

$$\mu = -\frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

For engineering materials, the value of poisson's ratio range between 0 to 0.5.

5. A square block is subjected to a state of simple shear. The linear strain of the diagonal shall be equal to :

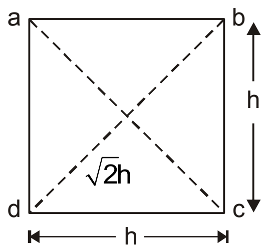
(a) Two times the shear strain

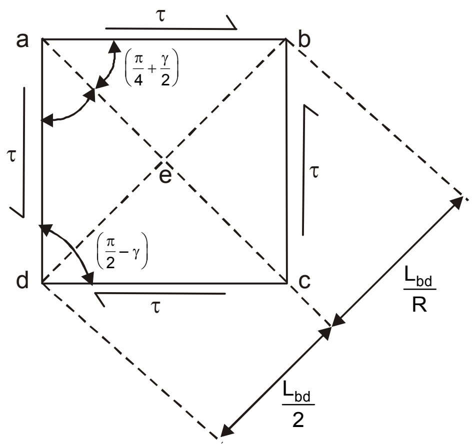
(b) The shear strain

(c) Half the shear strain

(d) One-fourth the shear strain

Sol–(c)





Let, ε = Normal strain along bd.

$$\Delta_{bd} = \sqrt{2}h \times \varepsilon \quad \text{...(i)}$$

$$\text{In } \Delta ade, \cos\left(\frac{\pi}{4} - \frac{\gamma}{2}\right) = \frac{\frac{L_{bd}}{2}}{h}$$

and in Δabd, $L_{bd} = \sqrt{2}h + \Delta_{bd}$

$$\cos\left(\frac{\pi}{4} - \frac{\gamma}{2}\right) = \frac{\sqrt{2}h + \Delta_{bd}}{2h}$$

$$\cos\frac{\pi}{4}.\cos\frac{\gamma}{2} + \sin\frac{\pi}{4}.\sin\frac{\gamma}{2} = \frac{1}{\sqrt{2}} + \frac{\Delta_{bd}}{2h}$$

$$\cos\frac{\gamma}{2} \simeq 1 \text{ and } \sin\frac{\gamma}{2} \approx \frac{\gamma}{2} \quad (\because \gamma = \text{small})$$

$$\therefore \frac{1}{\sqrt{2}}\left(1 + \frac{\gamma}{2}\right) = \frac{1}{\sqrt{2}} + \frac{\Delta_{bd}}{2h}$$

$$\Rightarrow \Delta_{bd} = \frac{\sqrt{2}h\gamma}{2}$$

From (i),

$$\sqrt{2}h \times \varepsilon = \frac{\sqrt{2}h\gamma}{2}$$

$$\Rightarrow \boxed{\varepsilon = \frac{\gamma}{2}} \quad \text{(Remember)}$$

6. The relation between Young's modulus (E) and modulus of rigidity (N) is given as :

(a) E = 3N(1 + μ) **(b) E = 2N(1 – μ)**

(c) E = 2N(1 + μ) **(d) E = 3N(1 – 2μ)**

Sol–(c)

The relation between the various modulus are given as:

$$\boxed{E = 2N(1+\mu) = 3k(1-2\mu)}$$

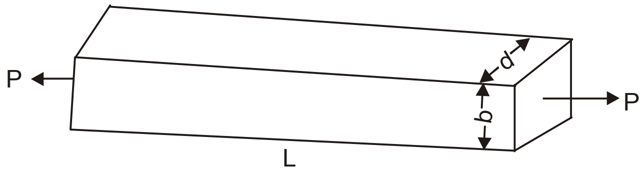
K = Bulk modulus

7. **If 'P' is the tensile stress in a rectangular bar of length 'L' with 'b' and thickness 'd', the volumetric strain is given as :**

(a) **P(1 + 2μ)/E** (b) **PL (1 – 2μ)/bd**

(c) **P(1 – 2μ)** (d) **P(1 – 2μ)/E**

Sol–(d)



Volumetric strain, $\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z$

$$= \left(\frac{P}{E}\right) + \left(-\mu\frac{P}{E}\right) + \left(-\mu\frac{P}{E}\right)$$

$$= \frac{P}{E}(1 - 2\mu)$$

2007

8. **The property of a material by which it can be drawn into smaller section by application of tension is called**

(a) **Plasticity** (b) **Ductility**

(c) **Elasticity** (d) **Malleability**

Sol–(b)

Plasticity: The characteristic of the material by virtue of which it undergoes inelastic strain beyond the strain at elastic limit is called plasticity.

Ductility: The property of a material by which a material can be drawn out in tension before it fracture. ***Ductility measurement can be done by using tension test.***

Elasticity: It is that property of material by virtue of which it returns to its original dimensions during unloading.

Malleability: It is a physical property of metals that defines their ability to be hammered, pressed or rolled into thin sheets without breaking.

2008

9. **Every material obeys Hooke's laws within its:**

(a) **Elastic limit**

(b) **Plastic limit**

(c) **Limit of proportionality**

(d) **None of the above**

Sol–(c)

Hooke's law: Stress $\propto$ strain

$\Rightarrow \quad \sigma \propto \varepsilon$

$\Rightarrow \quad \sigma = E\varepsilon$

→ Every material obey Hooke's law within its limit of proportionality.

→ ***Hooke's law is valid for homogeneous, isotropic and linearly elastic material.***

10. **If a uniform bar is supported at one end in a vertical direction and loaded at the bottom end by a load equal to the weight of the bar, the strain energy as compared to that due to self weight will be:**

(a) **Same** (b) **Half**

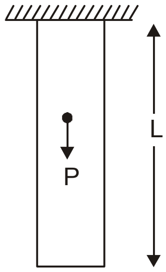
(c) **Twice** (d) **Thrice**

Sol–(d)

Strain energy in a axially loaded bar, $U = \frac{1}{2}P\delta$

Case–1: Strain energy due to self weight

Due to self weight $\delta, = \frac{PL}{2AE}$



Thus, $U_1 = \frac{1}{2}P.\frac{PL}{2AE} = \frac{P^2L}{4AE}$

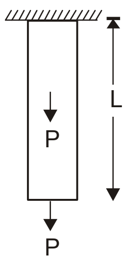
Case–2: Strain energy due to self weight and applied load

U_2 = Strain energy due to self weight + strain energy due to P at end

$$= \frac{P^2L}{4AE} + \frac{P^2L}{2AE}$$

$$= \frac{3P^2L}{4AE}$$

$$= 3U_1$$



11. The relation between Young's modulus (E) and modulus of rigidity (N) is given as :

(a) $E = 2N\left(1+\frac{1}{m}\right)$ **(b)** $E = 2N\left(1-\frac{1}{m}\right)$

(c) $E = \frac{2N}{\left(1+\frac{1}{m}\right)}$ **(d)** $E = \frac{1}{2N\left(1+\frac{1}{m}\right)}$

Sol–(a)

$$\boxed{E = 2N\left(1+\frac{1}{m}\right) = 3k\left(1-\frac{2}{m}\right)}$$

K = Bulk modulus, $\frac{1}{m} = \text{Poisson's ratio}$

2009

12. The % of elongation of the piece under tension indicates its :

(a) Brittleness **(b) Malleability**

(c) Stiffness **(d) Ductility**

Sol–(d)

- **Ductility:** The % of elongation of the piece under tension indicates its ductility.
- The property of a material by which a material can be drain out in tension before it fracture. Ductility measurement can be done by using tension test.
- Tendency of a material to fracture or fail at relatively small strain under the application of force, impact or shock, is called **brittleness**.
- **Stiffness** is the resistance of an elastic body to deflection or deformation by an applied force.

13. The relation with E (modulus of elasticity) and N (shear modulus) is given by :

(a) E = N(1 – 2μ) **(b) E = 2N(1 + μ)**

(c) E = 3N(1 – 2μ) **(d) None of the above**

Sol–(b)

The relation between the various modulus are given as:

$$\boxed{E = 2N(1+\mu) = 3k(1-2\mu)}$$

K = Bulk modulus

μ = Poisson's ratio

14. The ratio between stress and strain is called as

(a) Modulus of elasticity

(b) Modulus of rigidity

(c) Bulk modulus

(d) None of the above

Sol–(a)

Young's modulus (E) = $\frac{\text{Normal stress}}{\text{Normal strain}}$

Bulk modulus (K) = $\frac{\text{Normal (Volumetric) stress}}{\text{Volumetric strain}}$

Shear modulus (G) = $\frac{\text{Shear stress}}{\text{Shear strain}}$

Poisson's ratio (μ) = $-\frac{\text{Lateral strain}}{\text{Longitudinal strain}}$

2010

15. The limit of Poisson's ratio is :

(a) 0.25 **(b) 0.15**

(c) 0.50 **(d) 0.65**

Sol–(c)

The limit of Poisson's ratio is 0.50.

The ratio of lateral strain to longitudinal strain is known as poisson's ratio (μ).

$$\mu = -\frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

For engineering materials, the value of poisson's ratio range between 0 to 0.5.

16. Ductility of which of the following is the maximum?

(a) Mild steel **(b) Cast iron**

(c) Wrought iron **(d) Pig iron**

Sol–(c)

As the ***carbon content increases*** in iron, its ***ductility decreases.***

Carbon content in composite of Iron.

(i) Mild steel = < 0.3%