UPPSC-AE

UTTAR PRADESH PUBLIC SERVICE COMMISSION

Combined State Engineering
Services Examination

Assistant Engineer

Civil Engineering

Previous Years Solved Papers

Objective Papers

General Hindi

General Studies

Practice Questions

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UPPSC-AE : Civil Engineering Previous Solved Papers

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Preface

B. Singh (Ex. IES)

UPPSC Assistant Engineer Examination has been always preferred by Engineers due to job stability and opportunity to work in home sate. UPPSC Combined State Engineering Services examination is conducted time to time but not every year. MADE EASY team has made deep study of previous exam papers and observed that a good percentage of questions are of repetitive in nature, therefore previous year's papers are advisable to solve before a candidate takes the exam. This book is also useful for MP State Engineering Services, UPSC Engineering Services and other Competitive exams for Engineering graduates.

The current edition of this book contains complete solutions to all questions with accuracy. I have true desire to serve student community by providing good source of study and quality guidance. I hope this book will be proved an important tool to succeed in UPPSC and other competitive exams. Any suggestions from the readers for improvement of this book are most welcome.

With Best Wishes

B. Singh

CMD, MADE EASY

UPPSC : Exam Pattern

Combined State Engineering Services Examination
Assistant Engineer examination

Paper I : Objective **Maximum Time : 2½ Hours • Maximum Marks : 375** Each question carries 3 marks. There is a penalty of –1 mark for every wrong attempted answer	
General Hindi	25 Questions
Technical Paper I	100 Questions
Total	**125 Questions** (375 Marks)

Paper II : Objective **Maximum Time : 2½ Hours • Maximum Marks : 375** Each question carries 3 marks. There is a penalty of –1 mark for every wrong attempted answer	
General Studies	25 Questions
Technical Paper II	100 Questions
Total	**125 Questions** (375 Marks)

Uttar Pradesh Public Service Commission
Combined State Engineering Services Examination

Assistant Engineer

Civil Engineering

Paper-I (Part A)

Engineering Mechanics, Strength of Materials and Structural Analysis:
Units and Dimensions, SI units, vectors, concept of force, Concept of particle and rigid body Concurrent, Non- Concurrent and parallel forces in a plane, moment of force and varignon`s theorem free body diagram, conditions of equilibrium Principle of virtual work, equivalent force system. First and second Moment of area, Mass moment of inertia, Static Friction, inclined plane and bearings, kinematics and kinetics, kinematics in Cartesion and Polar Coordinates, motion under uniform and non-uniform acceleration, motion under gravity, Kinetics of particle: Momentum and Energy principles, D` Alembert`s principle, Collision of elastic bodies, rotation of rigid, bodies, simple harmonic motion.

Strength of Materials:
Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, bending stress, Shear Stress, Beams of uniform strength, Leaf Spring, close coiled helical springs, Strain Energy in direct stress, bending & shear. Deflection of beams; Macaulay's method, Mohr's Moment area method, Conjugate beam method, unit load method, Torsion of shafts, Transmission of power, Elastic stability of columns, Euler's Rankin's and Secant formulae. Principal stresses and strains in two dimensions, Mohr's Circle, Theories of Elastic Failure, Thin and Thick cylinder, Stresses due to internal and external pressure- Lame's equations.

Structural Analysis :
Castiglianios theorems I and II, Unit load method of consistent deformation applied to beams and pin jointed trusses. Slope-deflection, moment distribution, Kani's method of analysis and column Analogy method applied to indeterminate beams and rigid frames. Rolling loads and influence lines: Influence lines for reactions of beam, shear force and bending moment at a section of beam. Criteria for maximum shear force and bending moment in beams traversed by a system of moving loads, influence lines for simply supported plane pin jointed trusses,Arches: Three hinged, two hinged and fixed arches, rib shortening and temperature effects, influence lines in arches, Matrix methods of analysis: Force method and displacement method of analysis of indeterminate beams and rigid frames. Plastic Analysis of beams and frames: Theory of plastic bending, plastic analysis, statical method, Mechanism method. Unsymmetrical bending: Moment of inertia, product of inertia, position of neutral axis and principal axis, calculation of bending stresses.

(Part B)

Design of Structures: Steel, Concrete and Masonry Structures

Structural Steel Design:
Factors of safety and load factors, rivetted, bolted and welded joints and its connections, Design by working, stress/limit state method of tension and compression member, beams of built up section, rivetted and welded plate girders, gantry girders, stancheons with battens and lacings, slab and gussetted column bases, Design of highway and railway bridges: Through and deck type plate girder, Warren girder, Pratt truss.

Design of Concrete and Masonry Structures

Reinforced Concrete:
Working Stress and Limit State Method of design-Recommendations of B.I.S. codes, design of one way and two way slabs, stairs-case slabs, simple and continuous beams of rectangular, T and L sections, compression members under direct load with or without eccentricity, isolated and combined footings, Cantilever and counter-fort type retaining walls,Water tanks: Design requirements as per B.I.S. code for rectangular and circular tanks resting on ground, Prestressed concrete: Methods and systems of prestressing, anchorages, analysis and design of sections for flexure based on working stress, losses of prestress, Earth quake resistant design of building as per BIS code. Design of brick masonry as per I. S. Codes, Design of masonry retaining walls.

(Part C)

Building Materials, Construction Technology, Planning and Management

Building Materials:
Physical properties of construction materials with respect to their use: stones bricks, tiles, lime, glass, cement, mortars, Concrete, concept of mix design, pozzolans, plasticizers, super plasticizers, Special concrete: roller compacted concrete, mass concrete, self compacting concrete, ferro cement, fibre reinforced concrete, high strength concrete, high performance concrete, Timber: properties, defects and common preservation treatments, Use and selection of materials for various uses e.g. Low cost housing, mass housing, high rise buildings.

Constructions Technology, Planning and Management:
Masonry constructions using brick, stone, construction detailing and strength characteristics paints, varnishes, plastics, water proofing and damp proofing materials. Detailing of walls, floors, roofs, staircases, doors and windows. Plastering, pointing, flooring, roofing and construction features. Retrofitting of buildings, Principle of planning of building for residents and specific uses, National Building code provisions and uses. Basic principles of detailed and approximate estimating, specifications, rate analysis, principles of valuation of real property. Machinery for earthwork, concreting and their specific uses, factors affecting selection of construction equipments, operating cost of equipments. Construction activity, schedules, organizations, quality assurance principles. Basic principle of network CPM and PERT uses in construction monitoring, cost optimization and resource allocation. Basic principles of economic analysis and methods. Project profitability: Basis principles of financial planning, simple toll fixation criterions.

Geo Technical Engineering and Foundation Engineering
Types of soils, phase relationships, consistency limits particles size distribution, classifications of soils, structure and clay mineralogy. Capillary water, effective stress and pore water pressure, Darcy's Law, factors affecting permeability, determination of permeability, permeability of stratified soil deposits. Seepage pressure, quick sand condition, compressibility and consolidation, Terzaghi's theory of one dimensional consolidation, consolidation test. Compaction of soil, field control of compaction total stress and effective stress parameters, pore pressure parameters, shear strength of soils, Mohr Coulomb failure theory, shear tests.

Earth pressure at rest, active and passive pressures, Rankin's theory Coulomb's wedge theory, Graphical method of earth pressure on retaining wall, sheetpile walls, braced excavation, bearing capacity, Terzaghi and other important theories, net and gross bearing pressure. Immediate and consolidation settlement, stability of slope, total stress and effective stress methods, conventional methods of slices, stability number. Subsurface exploration, methods of boring, sampling, penetration tests, pressure meter tests, essential features of foundation, types of foundation, design criteria, choice of type of foundation, stress distribution in soils, Boussinessq's theory, Westergaard method, Newmarks chart, pressure bulb, contact, pressure, applicability of different bearing capacity theories, evaluation of bearing capacity from filed tests, allowable bearing capacity, settlement analysis, allowable settlement, proportioning of footing, isolated and combined footings, rafts, pile foundation, types of piles, plies capacity, static and dynamic analysis, design of pile groups, pile load test, settlement of piles lateral loads, foundation for bridges, Ground improvement techniques: sand drains, stone columns, grouting, soil stabilization geotextiles and geomembrane, Machine foundation: Natural frequency, design of machine foundations based on the recommendation of B.I.S. codes.

Paper-II (Part A)

Fluid Mechanics, Open Channel Flow, Hydraulic Machines and Hydro-power Engineering

Fluid Mechanics : Fluid properties and their roles in fluid motion, fluid statics including forces acting on plane and curved surfaces, Kinematics and Dynamics of Fluid flow: Velocity and acceleration, stream lines, equation of continuity, irrotational and rotational flow, velocity potential and stream functions, flownet, methods of drawing flownet, source and sink, flow separation, free and forced vorties.

Flow control volume equation, continuity, momentum and energy equations, Navier- Strokes equation, Euler's equation of motion and application to fluid flow problems, pipe flow, plane, curved, stationary and moving vanes sluice gates, weirs, orifice meters and Venturi meters.

Dimensional Analysis and Similitude: Buckingham's Pi-theorem, dimensionless parameters, similitude theory, model laws, undistorted and distorted models.

Laminar flow : Laminar flow between parallel, stationary and moving plates, flow through pipes.

Boundary Layer : Laminar and turbulent boundary layer on a flat plate, laminar sub-layer, smooth and rough boundaries, submerged flow, drag and lift and its applications.

Turbulent flow through pipes : Characteristics of turbulent flow, velocity distribution, pipe friction factor, hydraulic grade line and total energy line, siphons, expansion and contractions in pipes pipe networks, water hammer in pipes and surge tanks.

Open Channel Flow : Flow types, uniform and nonuniform flows, momentum and energy correction factors, Specific energy and specific force, critical depth, resistance equations and roughness coefficient, rapidly varied flow, flow in transitions, Brink flow, Hydraulic jump and its applications, waves and surges, gradually varied flow, classification of surface profiles, control section, Integration of varied flow equation and their solution.

Hydraulic Machines and Hydropower:

Centrifugal pumps-Types, characteristics, Net Positive Suction-head (NPSH), specific speed, Pumps in series and parallel. Reciprocating pumps, Air vessels, Hydraulic ram, efficiency parameters, Rotary and positive displacement pumps, diaphragm and jet pumps.

Hydraulic turbines : types, classification, Choice of turbines, performance parameters, controls, characteristics, specific speed.

Principles of hydropower development : Types, layouts and component works, surge tanks, 'types and choice, Flow duration curves and dependable flow, Storage and pondage, Pumped storage plants, Special types of hydel plants.

(Part B)

Hydrology and Water Resources Engineering

Hydrology: Hydrologic cycle, precipitation, evaporation, transpiration, infiltration, overland flow, hydrographs, flood frequency analysis, flood routing through a reservoir, channel flow routing- Muskingam method.

Ground Water Flow : Specific yield, storage coefficient, coefficient of permeability, confined and unconfined aquifers, radial flow into a well under confined and unconfined conditions, Openwells and tube wells. Ground and surface water recourses single and multipurpose projects, storage capacity of reservoirs, reservoir losses, reservoir sedimentation. Water requirements of crops consumptive use, duty and delta, irrigation methods, Irrigation efficiencies.

Canals : Distribution systems for cannal irrigation, canal capacity, canal losses, alignment of main and distributory canals, Design of cannal by kennedy's and Lacey's thoeorie, Water logging and its prevention.

Diversion head works : Compenents, Principles and design of weirs on permeable and impermeable foundations, Khosla's theory, Bligh's creep theory Storage works. Cross drainage works. Types of dams, design principles of gravity and earth dams, stability analysis. Spillways: Spillway types energy dissipation.

River training : Objectives of river training, methods of river training and bank protection.

(Part C)

Transportation Engineering

Highway Engineering : Principles of Highway alignments, classification and geometric design, elements and standards for roads.

Pavement: flexible and rigid pavements Design principles and methodology. Construction methods and materials for stabilized soil. WBM, Bituminous works and Cement Concrete roads.

Surface and sub-surface drainage arrangements for roads, culvert structures. Pavement distresses and strengthening by overlays. Traffic surveys and their application in traffic planning, Typical design features for channelized, intersection, rotary etc., signal designs, standard traffic signs and markings.

Railway Engineering: Permanent way, ballast, sleeper, chair and faslenings, points, crossings, different types of turn outs, cross-over, setting out of points, Maintenance of track, super elevation, creep of rails ruling gradients, track resistance tractive effort, curve resistance, Station yards and station buildings, platform sidings, turn outs, Signals and interlocking, level crossings.

Air port Engineering : Layouts, Planning and design.

(Part D)

Environmental Engineering

Water supply: Estimation of water demand, impurities in water and their significance, physical, chemical and bacteriological parameters and their analysis, waterborne diseases, standards for potable water.

Water collection & treatment: Intake structures, principles and design of sedimentation tank, coagulation cum flocculation units slow sand filter, rapid sand filter and pressure filter, theory & practices of chlorination, water softening, removal of taste and salinity, Sewerage Systems, Domestic and industrial wastes, storm, sewage, separate and combined systems, flow through sewers, design of sewers.

Waste water characterization: Solids, Dissolved oxygen (DO), BOD COD, TOC, and Nitrogen, Standards for disposal of effluent in normal water course and on to land.

Waste water treatment: Principles and design of wastewater Treatment units-- Screening, grit chamber, sedimentation tank activated sludge process, trickling filters, oxidation ditches, oxidation ponds, septic tank; Treatment and disposal of sludge; recycling of waste water.

Solid waste management: Classification, Collection and disposal of solid waste in rural and urban areas, Principles of solid waste management.

Environmental pollution : Air and water pollution and their control acts. Radioactive waste and their disposal Environmental impact assessment of Thermal power Plants, mines and river valley projects, Sustainable development.

(Part E)

Survey and Engineering Geology

(a) Surveying: Common methods and instruments for distance and angle measurements in Civil Engineering works, their use in plane table traverse survey, levelling, triangulation, contouring and topographical maps. Survey layouts for culverts canal, bridge, roads, railway alignment and buildings.

Basic principles of photogrammetry and remote sensing.

Introduction to Geographical information system.

Engineering Geology : Basic concepts of Engineering geology and its applications in projects such as dams, bridges and tunnels.

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Civil Engineering

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UPPSC-AE

Combined State Engineering
Services Examination

Section-A

Civil Engineering

Objective Previous Years Questions

1

Engineering Mechanics

2007 (II)

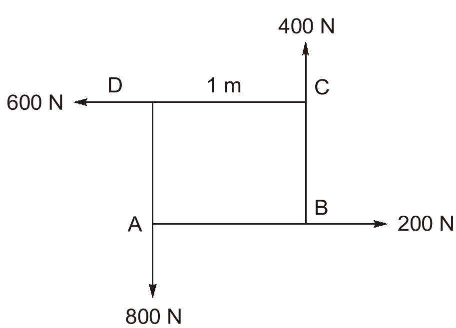
Q.1 Moment of Inertia of a triangular cross-section of height d and base width b about its centroid axis parallel to base is

(a) $\frac{bd^3}{36}$ (b) $\frac{bd^3}{24}$

(c) $\frac{bd^3}{12}$ (d) $\frac{bd^3}{6}$

2019

Q.2 Four forces having magnitudes of 200 N, 400 N, 600 N and 800 N, respectively acting along four sides (1 m each) of a square ABCD as shown in figure. Determine the magnitude and direction of the resultant force from 'A' along the line 'AB'.



(a) $400\sqrt{3}$ N, 3.2 m from A

(b) $400\sqrt{2}$ N, 2.5 m from A

(c) $300\sqrt{2}$ N, 2 m from A

(d) $300\sqrt{3}$ N, 2.5 m from A

Q.3 A bullet of mass 30 gm leaves the barrel of a gun with a velocity of 500 m/s. Suppose, the force lasted, for 0.0018 seconds, the average impulsive force is

(a) 5333.33 N (b) 6333.33 N

(c) 7333.33 N (d) 8333.33 N

Q.4 A particle undergoes a simple harmonic motion, the acceleration of the particle at a distance of 1.5 m from the centre of motion being 6 m/s^2, the time of oscillation in seconds is

(a) 2.00 (b) 4.00

(c) 3.14 (d) 6.28

Q.5 The coefficient of friction is the ratio of

(a) Limiting friction force to the normal reaction

(b) Limiting friction force to the weight of body to be moved

(c) Sliding friction force to the normal reaction

(d) None of the above

Q.6 The D'Alembert principle

(a) is a hypothetical principle

(b) provides no special advantage over Newton's law

(c) is based upon the existence of inertia force

(d) allows a dynamical problem to be considered as a static problem

2021

Q.7 Which theorem/principle may be stated as the net external forces acting on the system and the resultant reversed effective forces (internal force) are in equilibrium?

(a) Lami's theorem

(b) Varignon's theorem

(c) D'Alembert's principle

(d) None of the above

Q.8 If a particle is moving with simple harmonic motion, the velocity is ____ at the mean position.

(a) Maximum (b) Zero

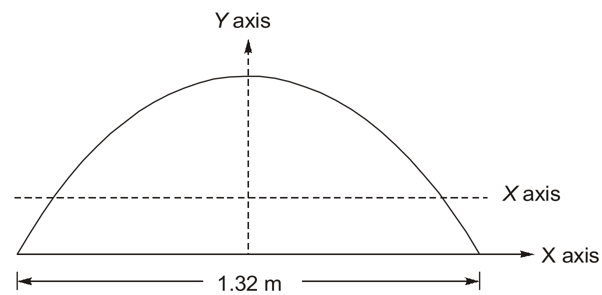
(c) Minimum (d) None of these

Q.9 The ratio of distance moved by effort to distance moved by load is called
(a) Resistance of machine
(b) Mechanical advantage
(c) Effect ratio
(d) Velocity ratio

Q.10 The forces which meet at one point, but their line of action do not lie in a plane are called
(a) Intersecting forces
(b) Coplanar non-concurrent forces
(c) Non-coplanar non-concurrent forces
(d) Non-coplanar concurrent forces

Q.11 Ball A of mass 2 kg moving with a velocity of 2 m/s, strikes directly on a ball B of mass 4 kg at rest. The ball A, after striking comes to rest. Find the coefficient of restitution after the collision.
(a) 1.00 (b) 0.5
(c) 0.67 (d) 0.33

Q.12 The Y axis of centre of gravity of semicircular plate 1.32 m diameter from its base as shown in figure.



(a) 0.14 m (b) 0.21 m
(c) 0.28 m (d) None of these

■■■■

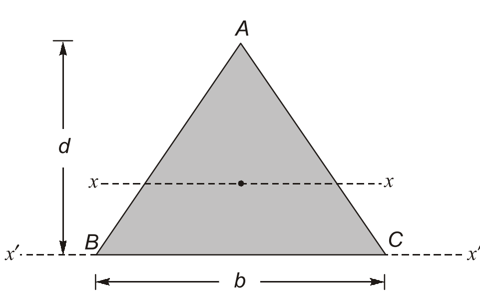
Answers | Engineering Mechanics

1.	(a)	2.	(b)	3.	(d)	4.	(c)	5.	(a)	6.	(d)
7.	(c)	8.	(a)	9.	(d)	10.	(d)	11.	(b)	12.	(c)

Explanations | Engineering Mechanics

1. (a)

We know that

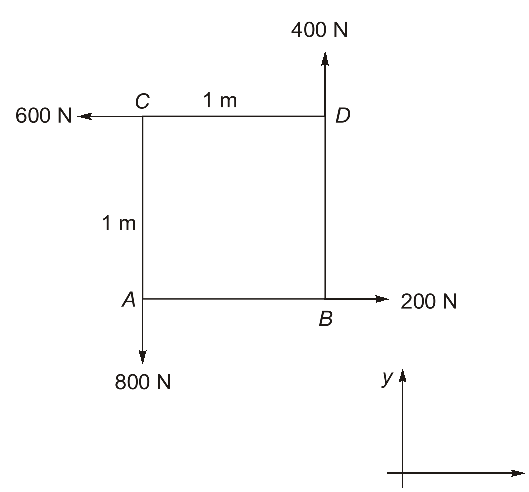


$$I_x' = \frac{bd^3}{12}$$

$$I_x = \frac{bd^3}{36}$$

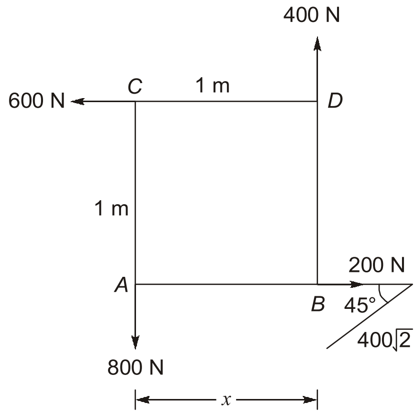
Hence option (a) is correct.

2. (b)



$$\Sigma F_x = -400 \text{ N}$$
$$\Sigma F_y = -400 \text{ N}$$

So resultant force = $400\sqrt{2}$ N



$$\Sigma M_A = 0$$
$$\left(400\sqrt{2}\sin 45°\right)x = 4w + 600$$
$$x = 2.5 \text{ m}$$

3. (d)

Average impulsive force,

$$I = \frac{MW}{dt} = \frac{30\times10^{-3}\times500}{0.0018}$$
$$= 8333.3 \text{ N}$$

4. (c)

$$F = ma$$
$$\text{Spring force} = kx$$
$$6 \text{ m} = 1.5\ k$$
$$k/m = 4$$

Time of oscillation (sec)

$$= 2\pi\left(\sqrt{\frac{m}{k}}\right) = 2\pi\sqrt{\frac{1}{4}}$$
$$= \frac{2\pi}{2} = \pi = 3.14 \text{ sec}$$

5. (a)

$$f = \frac{\text{Limting friction force}}{\text{Normal reaction}}$$

7. (c)

Lami's theorem relates the magnitudes of three coplanar, concurrent and non-collinear vectors, which keeps an object in static equilibrium, with the angles directly opposite to the corresponding vectors.

Varignon's theorem states that the moment of any force is equal to the algebraic sum of the moments of the components of that force.

D'Alembert's principle states that the net external forces acting on the system and the resultant reversed effective forces are in equilibrium.

8. (a)

At mean position, velocity is maximum and acceleration is 0.

10. (d)

Concurrent → Passing through same point

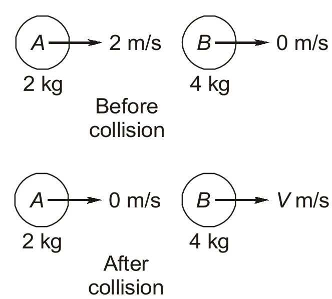
Coplanar → Lying in the same plane

Collinear → Having a common line of action

11. (b)

Coefficient of restitution (e)

$$= \frac{\text{Velocity of Separation}}{\text{Velocity of Approach}}$$



Applying Momentum Conservation:

$\Rightarrow$ $M_A u_A + M_B u_B = M_A V_A + M_B V_B$

$\Rightarrow$ $2(2) + 4(0) = 2(0) + 4(V)$

$\Rightarrow$ $4 = 4\text{ V}$

$\Rightarrow$ $V = 1$ m/s

Now, $$e = \frac{V_B - V_A}{u_A - u_B} = \frac{V-0}{2-0} = \frac{1}{2} = 0.5$$

12. (c)

y-co-ordinate of C.G of semi-circle

$$= \frac{4R}{3\pi}$$
$$R = \text{Radius} = \frac{1.32}{2} = 0.66 \text{ m}$$
$$y = \frac{4\times0.66}{3\pi} = 0.28 \text{ m}$$

■■■■

2 Strength of Materials

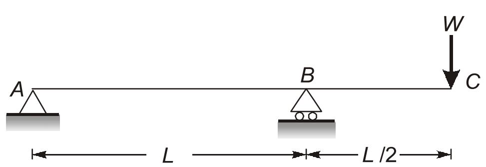
2003

Q.1 A simply supported beam of span L and flexural rigidity EI, carries a unit point load at its centre. The strain energy in the beam due to bending is

(a) $\frac{L^3}{48EI}$ (b) $\frac{L^3}{192EI}$

(c) $\frac{L^3}{96EI}$ (d) $\frac{L^3}{16EI}$

Q.2 An overhang beam of uniform EI is loaded as shown in the Figure. The deflection at the free end is



(a) $\frac{WL^3}{81EI}$ (b) $\frac{WL^3}{8EI}$

(c) $\frac{WL^3}{27EI}$ (d) $\frac{2WL^3}{27EI}$

Q.3 The number of independent equations to be satisfied for static equilibrium of a plane structure is

(a) 1 (b) 2

(c) 3 (d) 6

Q.4 Which one of the following pairs is not correctly matched

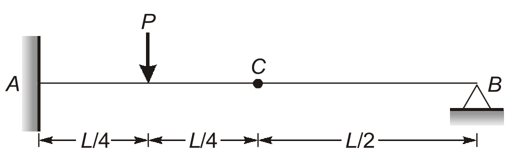
Boundary Conditions of Column	Euler's Buckling Load
(a) Both pined	1. $\pi^2 EI / L^2$
(b) Both fixed	2. $4\pi^2 EI / L^2$
(c) One fixed one free	3. $0.25\,\pi^2 EI / L^2$
(d) One fixed one pined	4. $\sqrt{2}\pi^2 EI / L^2$

Q.5 A rectangular beam of width 200 mm and depth 300 mm is subjected to a shear force of 200 kN. The maximum shear stress produced in the beam is

(a) 10.0 N/mm^2 (b) 7.5 N/mm^2

(c) 5.0 N/mm^2 (d) 3.33 N/mm^2

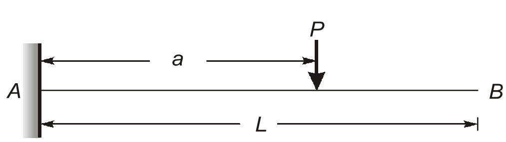
Q.6 For the propped cantilever shown in figure, the vertical reaction at the fixed end is



(a) $\frac{4P}{3}$ (b) P

(c) $\frac{3P}{4}$ (d) $\frac{P}{2}$

Q.7 In a cantilever beam of uniform flexural rigidity EI and loaded as shown in the figure, the deflection at free end 'B' would be



(a) $\frac{Pa(3l^2 - a^2)}{6EI}$ (b) $\frac{Pa^2(l - a)}{6EI}$

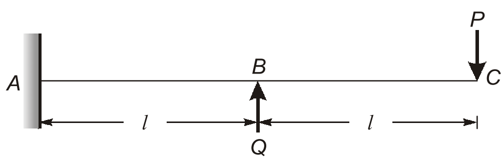
(c) $\frac{P(l - a)^2}{6EI}$ (d) $\frac{Pa^2(3l - a)}{6EI}$

Q.8 The variation of shear stress at a section of a beam is

(a) Constant (b) Linear

(c) Parabolic (d) Cubic

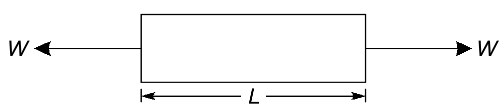
Q.9 For the beam shown below the ratio of P/Q, when deflection at C = 0; is



(a) $\frac{3}{8}$ (b) $\frac{5}{8}$

(c) $\frac{3}{16}$ (d) $\frac{5}{16}$

Q.10 The value of axial strain energy of the member shown in figure is



A = Area of cross-section
E = Modulus of elasticity

(a) $\frac{W^2L}{4AE}$ (b) $\frac{W^2L}{3EI}$

(c) $\frac{W^2L}{2AE}$ (d) $\frac{W^2L}{AE}$

2004

Q.11 A beam is capable of resisting
(a) axial force only
(b) shear force only
(c) bending moment only
(d) All the above

Q.12 The relation between transverse load and shear in a beam is

(a) $w = \frac{dV}{dx}$ (b) $\frac{dw}{dx} = V$

(c) $wL = V$ (d) $\frac{d^2w}{dx^2} = V$

Where symbols have their usual meaning.

Q.13 Shear force at any section is the algebraic sum of the following on either side of member.
(a) Axial force (b) Transverse force
(c) Moments (d) None of the above

Q.14 The maximum bending moment in a simply supported beam subjected to a point load occurs
(a) at one of the supports
(b) at mid span
(c) at quarter span
(d) under the point load section

Q.15 Under uniformly distributed load, the shear varies
(a) constant (b) linearly
(c) parabolically (d) cubieally

Q.16 Between point loads, the shear varies
(a) constant (b) linearly
(c) parabolically (d) cubically

Q.17 At a hinge the bending moment is
(a) always sagging (b) always hogging
(c) always zero (d) always maximum

Q.18 In a frame the point of inflection occurs in
(a) beam only
(b) column only
(c) beam column joint
(d) anywhere in the frame

Q.19 Shear stress at a section in a beam is zero at
(a) extreme top and bottom fibre
(b) neutral axis
(c) mid depth
(d) none of these

2007 (I)

Q.20 The stiffness of a spring is defined as :
(a) Force required to cause unit displacement
(b) Displacement produced by unit force
(c) Force in the spring corresponding to zero displacement
(d) None of the above

Q.21 The relation between shear force (V) and bending moment (M) in a beam is:

(a) $\frac{dV}{dx} = M$ (b) $V = \frac{dM}{dx}$

(c) $V = \int M dx$ (d) $V = \frac{d^2M}{dx^2}$

Q.22 A level cantilever beam of uniform section propped at free end on unyielding support carries a point load W at mid span. The reaction at prop is:

(a) 3 $W/8$ (b) 5 $W/8$
(c) 3 $W/16$ (d) 5 $W/16$

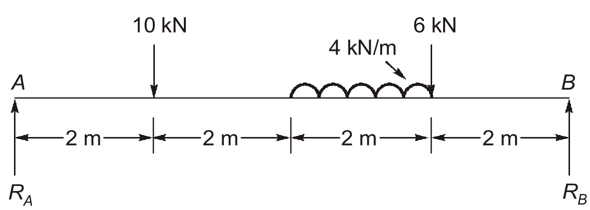
Q.23 The conjugate beam for a fixed ended beam is:

(a) A beam free at both ends
(b) A beam hinged at both ends
(c) A beam simply supported at both ends
(d) A beam free at one end and hinged at other end

Q.24 The ratio of the maximum shear stress to average shear stress in a beam with rectangular cross-section is:

(a) 0.5 (b) 1.0
(c) 1.5 (d) 2.0

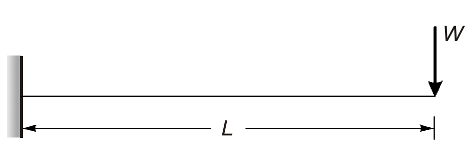
Q.25 The ratio of reactions R_A and R_B in the simply supported beam shown in figure is :



(a) 0.50 (b) 0.75
(c) 1.00 (d) 1.50

2007 (II)

Q.26 Maximum deflection of the cantilever beam *AB* subjected to a point load *W* at *B* is given by



(a) $\frac{WL^3}{2EI}$ (b) $\frac{WL^3}{3EI}$

(c) $\frac{WL^3}{4EI}$ (d) $\frac{WL^3}{5EI}$

Q.27 For a simply supported beam subjected to a load w per unit length, the end slope is given by

(a) $\frac{wL^3}{24EI}$ (b) $\frac{wL^3}{12EI}$

(c) $\frac{wL^3}{6EI}$ (d) $\frac{wL^3}{3EI}$

Q.28 The relation between Shear force and Bending moment in a beam is

(a) $V = \frac{d^2M}{du^2}$ (b) $V = \frac{dM}{du}$

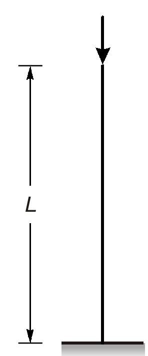
(c) $V = \int M du$ (d) $V = \frac{d^3M}{du^3}$

V = Shear force
M = Bending moment

Q.29 A portion of a beam between two sections is said to be in pure bending when there is

(a) constant bending moment and constant shear force
(b) constant shear force and zero bending moment
(c) constant bending moment and zero shear force
(d) zero bending moment and zero shear force

Q.30 Buckling load of a column fixed at lower end is given by



(a) $\frac{\pi^2EI}{4L^2}$ (b) $\frac{\pi^2EI}{3L^2}$

(c) $\frac{\pi^2EI}{2L^2}$ (d) $\frac{\pi^2EI}{L^2}$

Q.31 A simply supported beam is acted upon by a concentrated load at its centre. It causes a maximum deflection of 10 mm and slope at its ends of 0.002 radians. The span of the beam is

(a) 10 m (b) 12 m
(c) 15 m (d) 16 m

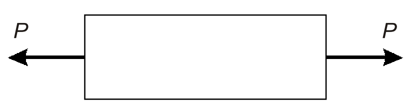
Q.32 A simply supported beam of span l carries a uniformly distributed load of w per unit length and whole span. Flexural rigidity being EI. The maximum deflection of beam is given by

(a) $\dfrac{wl^2}{8EI}$ (b) $\dfrac{wl^2}{24EI}$

(c) $\dfrac{wl^3}{6EI}$ (d) $\dfrac{5wl^4}{384EI}$

Q.33 The maximum shear stress occurs on
(a) Principal plane
(b) 45° with principal plane
(c) 90° with principal plane
(d) Independent of principal plane

Q.34 The value of axial strain energy of the member shown in figure is



(a) $\dfrac{P^2L}{AE}$ (b) $\dfrac{P^2L}{2AE}$

(c) $\dfrac{P^2L}{3AE}$ (d) $\dfrac{P^2L}{4AE}$

P = Axial load
A = Area of cross section
E = Modulus of elasticity

2008

Q.35 The energy stored in a structural member is called resilience when the member is deformed
(a) within the limit of proportionality
(b) upto elastic limit
(c) till fracture point
(d) half of elastic limit

Q.36 A beam of span 'L' of flexural rigidity 'EI' and subjected to bending moment 'M', the strain energy stored is equal to

(a) $\int_0^L \dfrac{M}{2EI}dx$ (b) $\int_0^L \dfrac{M^2}{EI}dx$

(c) $\int_0^L \dfrac{M}{EI}dx$ (d) $\int_0^L \dfrac{M^2}{2EI}dx$

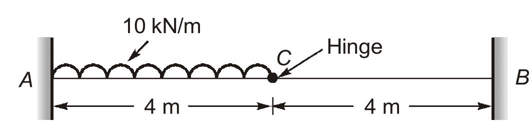
Q.37 Shear force at any section of a conjugate beam shows the following in the actual beam as
(a) Deflection (b) Slope
(c) Bending moment (d) Shear force

Q.38 The deflection at any section of a beam, shows the following in the same section of a conjugate beam as
(a) Shear force (b) Load
(c) Bending moment (d) Deflection

Q.39 The fixed end in a conjugate beam is taken in actual beam as
(a) simply supported (b) free end
(c) fixed (d) hinged

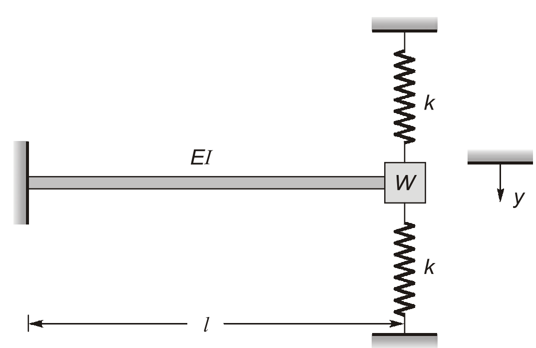
2011

Q.40 The reaction at C of the beam shown is



(a) 5.5 kN (b) 6.5 kN
(c) 7.5 kN (d) 8.5 kN

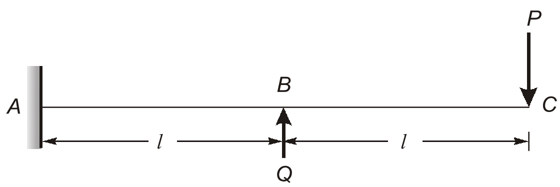
Q.41 For the beam shown below, the equivalent spring stiffness of the system is



(a) $\dfrac{3EI}{l^3} + 2k$ (b) $\dfrac{3EI}{l^3} + \dfrac{1}{2k}$

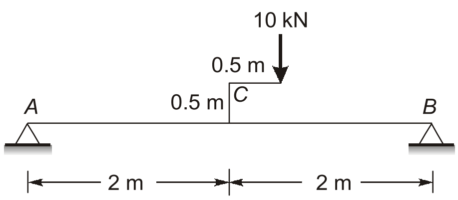
(c) $\dfrac{l^3}{3EI} + \dfrac{1}{2k}$ (d) $\dfrac{l^3}{3EI} + 2k$

Q.42 For the beam shown below the ratio of P/Q, when deflection at $C = 0$; is



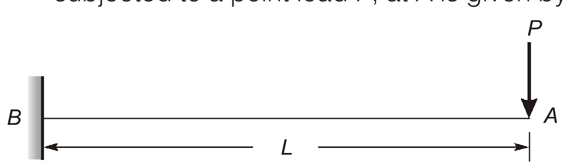
(a) 3/8 (b) 5/8
(c) 3/16 (d) 5/16

Q.43 The reaction at support 'B' of the statically determinate beam shown below is



(a) 3.75 kN (b) 4.25 kN
(c) 5.75 kN (d) 6.25 kN

Q.44 Maximum slope of the cantilever beam AB subjected to a point load P, at A is given by



(a) $\dfrac{PL^2}{2EI}$ (b) $\dfrac{PL^2}{3EI}$

(c) $\dfrac{PL^2}{4EI}$ (d) $\dfrac{PL^2}{5EI}$

Q.45 A simply supported beam is acted upon by a concentrated load at its centre. It causes slope at its ends of 0.002 radians and a maximum deflection of 10 mm. The span of the beam is

(a) 8 m (b) 12 m
(c) 15 m (d) 18 m

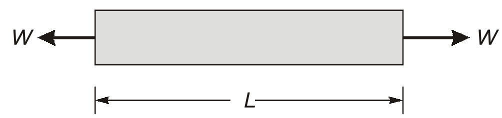
Q.46 The conjugate beam for a fixed beam is a

(a) beam fixed at both ends
(b) beam simply supported at both ends
(c) beam free at the both ends
(d) beam hinged at both sides

Q.47 A portion of a beam between two section is said to be in pure bending when, there is

(a) constant bending moment and constant shear force
(b) constant shear force and zero bending moment
(c) zero bending moment and zero shear force
(d) constant bending moment and zero shear force

Q.48 The value of axial strain energy of the member shown in figure is



A = area of cross-section;
E = modulus of elasticity

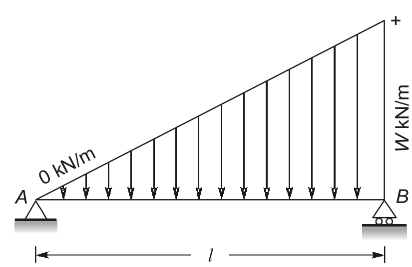
(a) $\dfrac{W^2L}{4AE}$ (b) $\dfrac{W^2L}{3AE}$

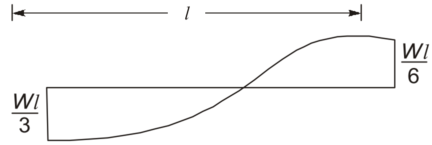
(c) $\dfrac{W^2L}{2AE}$ (d) $\dfrac{W^2L}{AE}$

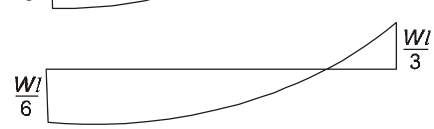
Q.49 A simply supported beam of span l, carries a uniformly distributed load of 'w' per unit length over the whole span. Flexural rigidity of beam is EI. The maximum deflection of beam is given by

(a) $wl^3/8EI$ (b) $5wl^4/424EI$
(c) $wl^3/48EI$ (d) $5wl^4/384EI$

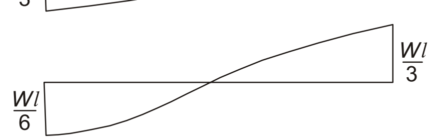
Q.50 The shear force diagram for the statically determinate beam shown below is



(a)


(b)


(c)


(d)


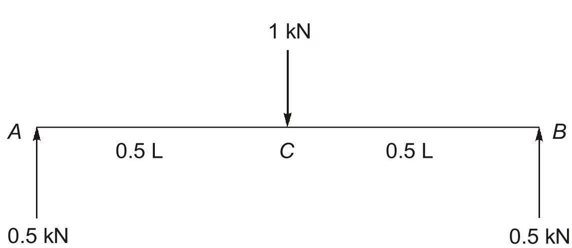
Answers | Strength of Materials

1.	(c)	17.	(c)	33.	(b)	49.	(d)	65.	(c)	81.	(b)
2.	(b)	18.	(d)	34.	(b)	50.	(d)	66.	(a)	82.	(d)
3.	(c)	19.	(a)	35.	(b)	51.	(b)	67.	(c)	83.	(b)
4.	(d)	20.	(a)	36.	(d)	52.	(b)	68.	(a)	84.	(a)
5.	(c)	21.	(b)	37.	(b)	53.	(c)	69.	(d)	85.	(c)
6.	(b)	22.	(d)	38.	(c)	54.	(c)	70.	(a)	86.	(c)
7.	(d)	23.	(a)	39.	(b)	55.	(d)	71.	(b)	87.	(c)
8.	(c)	24.	(c)	40.	(c)	56.	(d)	72.	(c)	88.	(b)
9.	(d)	25.	(c)	41.	(a)	57.	(c)	73.	(a)	89.	(b)
10.	(c)	26.	(b)	42.	(d)	58.	(a)	74.	(c)	90.	(c)
11.	(d)	27.	(a)	43.	(d)	59.	(c)	75.	(b)	91.	(a)
12.	(a)	28.	(b)	44.	(a)	60.	(b)	76.	(a)	92.	(c)
13.	(b)	29.	(c)	45.	(c)	61.	(d)	77.	(b)	93.	(a)
14.	(d)	30.	(a)	46.	(c)	62.	(c)	78.	(d)	94.	(d)
15.	(b)	31.	(c)	47.	(d)	63.	(b)	79.	(b)	95.	(a)
16.	(a)	32.	(d)	48.	(c)	64.	(d)	80.	(d)	96.	(d)

Explanations | Strength of Materials

1. (c)

Strain energy due to bending = $\int \frac{M_x^2 dx}{2EI}$



$$M_x = 0.5x$$

$$U = 2U_{AC} = 2\int_0^{\frac{L}{2}} \frac{M_x^2 dx}{2EI} = 2\int_0^{\frac{L}{2}} \frac{\left(\frac{1}{2}x\right)^2 dx}{2EI}$$

$$U = \frac{2}{2EI} \times \frac{1}{4}\int_0^{\frac{L}{2}} x^2 dx = \frac{1}{4EI}\left[\frac{x^3}{3}\right]_0^{\frac{L}{2}}$$

$$U = \frac{L^3}{96EI}$$

Alternative Approach:

We know, strain energy,

$$U = \text{work done}$$

$$U = \frac{1}{2} \times P \times \Delta$$

$$U = \frac{1}{2} \times P \times \frac{PL^3}{48EI}$$

$$U = \frac{P^2L^3}{96EI}$$

Here $P = 1$ kN,

$$\therefore \quad U = \frac{L^3}{96EI}$$

Hence option (c) is correct.