GATE SOLUTIONS

CIVIL ENGINEERING

1987-2024

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PREFACE

The Graduate Aptitude Test in Engineering (GATE) is an All-India examination administered and conducted in eight zones across the country by the GATE Committee comprising of Faculty members from IISc, Bangalore and other seven IITs on behalf of the National Coordinating Board, Department of Education, Ministry of Human Resources Development.

The GATE score/rank is used for admissions to Post Graduate Programmes (ME, M.Tech, MS, direct PhD) in institutes like IIT and IISc, etc. with financial assistance offered by the Ministry of Human Resource Development. PSUs too use the GATE scores for recruiting candidates for various prestigious jobs with attractive remuneration.

The door to GATE exam is through previous year question papers. If you are able to solve question papers in access of 10 years, you are sure to clear the GATE exam, and open new vistas of career and learning.

The **Civil Engineering GATE 2025** book from IES Master offers detailed topic-wise solutions for the past **38 years** question papers. The emphasis is clearly on the understanding of concepts and building upon a holistic picture. So as you finish a topic, for instance, Strength of Materials, you will find all the previous years' question papers with detailed explanation under that particular topic.

The approach has been to provide explanation in such a way that just by going through the solutions, students will be able to understand the basic concepts and will apply these concepts in solving other questions that might be asked in future exams.

Every care has been taken to bring an error-free book. However, comments, suggestions, and feedback for improvement in the future editions are most welcome.

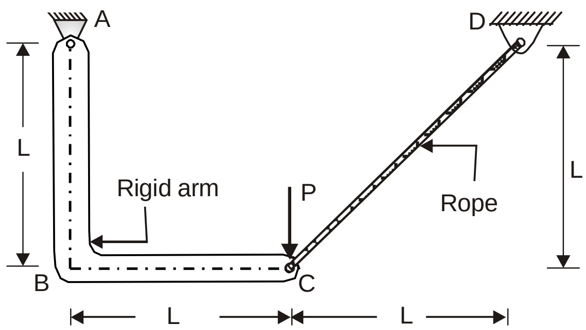
IES Master Publication
New Delhi

CONTENT

1 ENGINEERING MECHANICS

1– Mark

1. An assembly made of a rigid arm A-B-C at end A and supported by an elastic rope C-D at end C is shown in the figure. The members may be assumed to be weightless and the lengths of the respective members are as shown in the figure.



Under the action of a concentrated load P at C as shown, the magnitude of tension developed in the rope is

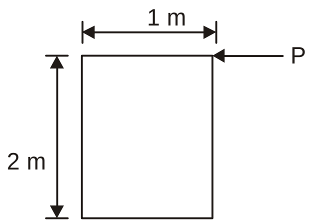
(a) $\frac{3P}{\sqrt{2}}$ (b) $\frac{P}{\sqrt{2}}$

(c) $\frac{3P}{8}$ (d) $\sqrt{2}P$

[GATE–2016 SHIFT-II]

2– Marks

2. A horizontal force of P kN is applied to a homogeneous body of weight 25 kN, as shown in the figure. The coefficient of friction between the body and the floor is 0.3. Which of the following statement(s) is/are correct?



(a) The motion of the body will occur by over-turning.

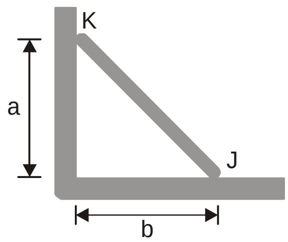
(b) Sliding of the body never occurs.

(c) No motion occurs for P $\leq$ 6 kN.

(d) The motion of the body will occur by sliding only.

[GATE–2022 SHIFT-I]

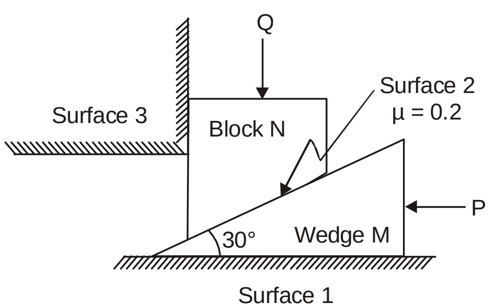
3. A uniform rod KJ of weight w shown in the figure rests against a frictionless vertical wall at the point K and a rough horizontal surface at point J. It is given that w = 10 kN, a = 4 m and b = 3 m.



The minimum coefficient of static friction that is required at the point J to hold the rod in equilibrium is _______ (round off to three decimal places)

[GATE–2022 SHIFT-II]

4. A wedge M and a block N are subjected to forces P and Q as shown in the figure. If force P is sufficiently large, then the block N can be raised. The weights of the wedge and the block are negligible compared to the force P and Q. The coefficient of friction (μ) along the inclined surface between the wedge and the block is 0.2 all other surfaces are frictionless. The wedge angle is 30°.



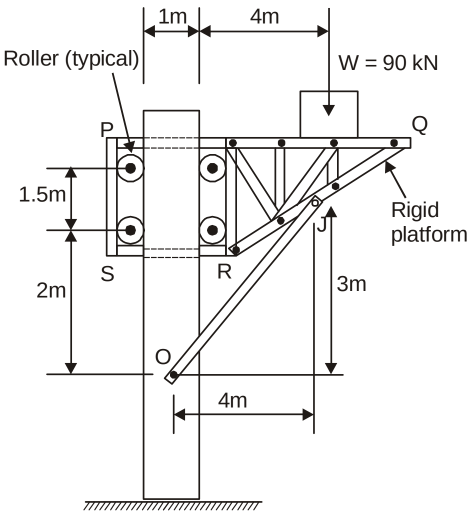
The limiting force P, in terms of Q, required for impending motion of block N to just move it in the upward direction is given as P = αQ. The value of the coefficient 'α' (round off to one decimal place) is

(a) 2.0 (b) 0.5

(c) 0.9 (d) 0.6

[GATE–2021 SHIFT-I]

5. A rigid weightless platform PQRS shown in the figure (not drawn to the scale) can slide freely in the vertical direction. The platform is held in position by the weightless member OJ and four weightless, frictionless rollers. Points O and J are pin connections. A block of 90 kN rests on the platform as as shown in the figure



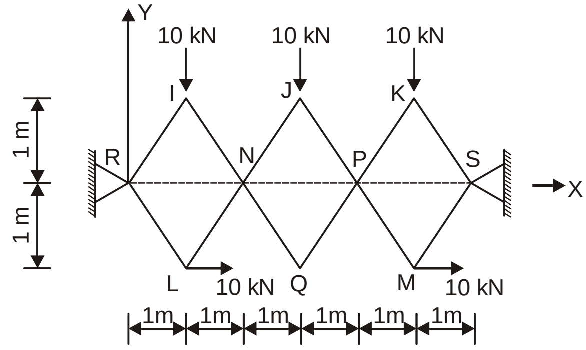
The magnitude of horizontal component of the reaction (in kN) at pin O, is

(a) 120 (b) 180

(c) 150 (d) 90

[GATE–2020 SHIFT-I]

6. Joints I, J, K, L, Q and M of the frame shown in the figure (not drawn to the scale) are pins. Continuous members IQ and LJ are connected through a pin at N. Continuous members JM and KQ are connected through a pin at P. The frame has hinge supports at joints R and S. The loads acting at joints I, J and K are along the negative Y direction and the load acting at joint L and M are along the positive X direction.



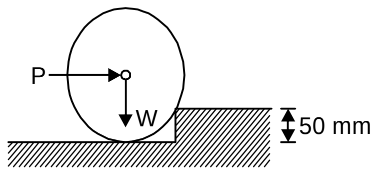
The magnitude of the horizontal component of reaction (in kN) at S, is

(a) 15 (b) 20

(c) 10 (d) 5

[GATE–2020 SHIFT-II]

7. A cylinder of radius 250 mm and weight, W = 10 kN is rolled up an obstacle of height 50 mm by applying a horizontal force P at its centre as shown in the figure.



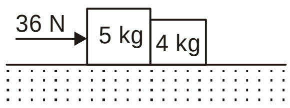
All interfaces are assumed frictionless. The minimum value of P is

(a) 4.5 kN (b) 5.0 kN

(c) 6.0 kN (d) 7.5 kN

[GATE–2018 SHIFT-I]

8. Two rigid bodies of mass 5 kg and 4 kg are at rest on a frictionless surface until acted upon by a force of 36 N as shown in the figure. The contact force generated between the two bodies is



(a) 4.0 N (b) 7.2 N
(c) 9.0 N (d) 16.0 N

[GATE–2018 SHIFT-II]

9. A particle of mass 2 kg is travelling at a velocity of 1.5 m/s. A force f(t) = $3t^2$ (in N) is applied to it in the direction of motion for a duration of 2 seconds. Where t denotes time in seconds. The velocity (in m/s up to one decimal place) of the particle immediately after the removal of the force is ______.

[GATE–2017 SHIFT-I]

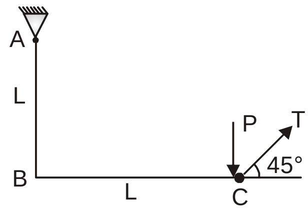
ANSWER KEY

1 Mark : –	:–– : 2 Marks : –	
1. (b)	**2.** **(a, c)**	**6.** (a)
	3. **(0.375)**	**7.** (d)
	4. (c)	**8.** (d)
	5. (a)	**9.** (5.5 m/s)

EXPLANATIONS

1– Mark

1. (b) $\frac{P}{\sqrt{2}}$



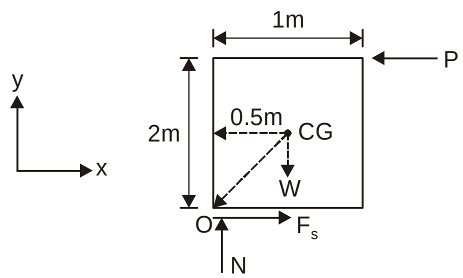
Taking moment about A

$$PL = \frac{T}{\sqrt{2}}L + \frac{T}{\sqrt{2}}L \Rightarrow \sqrt{2}T = P$$

$$\Rightarrow \boxed{T = \frac{P}{\sqrt{2}}}$$

2– Marks

2. (a, c)



Motion of block will occur in two ways, the block may slide to the left or it may tip about edge O.

Case-I: Checking motion of block in sliding

$\Sigma F_x = 0$

$P - F_s = 0$

$P = F_s$

and

$\Sigma F_y = 0$

$N - W = 0$

$N = W = 25$ kN

So, force due to friction (F_s) = μN

= 0.3 × 25 = 7.5 kN

Hence sliding will occur at 7.5 kN.

Case-II: Checking motion of block against tipping (over turning)

$\Sigma M_O = 0$ ⊕

$-P \times 2 + W \times 0.5 = 0$

$2 \times P = 25 \times 0.5$

$$P = \frac{25 \times 0.5}{2} = 6.25 \text{ kN}$$

Block will overturn at P = 6.25 kN

As it not mentioned that load is increased gradually, hence

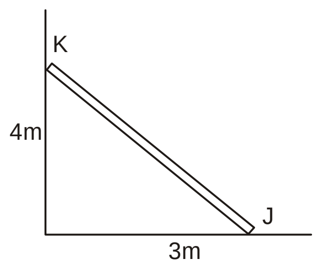
(i) for P < 6.25 kN, No motion occurs

(ii) $6.25 \le P < 7.5$ kN, motion of block will occur by overturning only

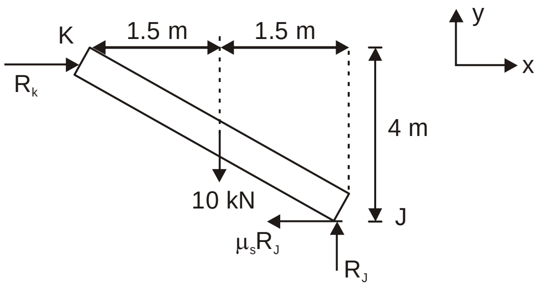
(iii) For P > 7.5 kN, motion of block will occur both by sliding and overturning.

Hence, option (a), and (c) are correct.

3. **(0.375)**



FBD



$$\Sigma F_V = 0$$

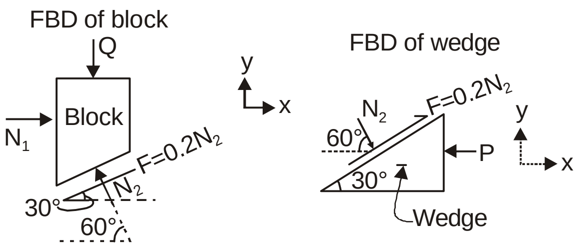
$$\Rightarrow \quad \boxed{R_J = 10\,kN}$$

$$\sum M_K = 0$$

$$\Rightarrow \quad 10 \times 1.5 + \mu_s R_J \times 4 - R_J \times 3 = 0$$

$$\Rightarrow \quad \mu_s = \frac{10 \times 3 - 10 \times 1.5}{10 \times 4} = 0.375$$

4. (c)



$\sum F_y = 0$ on block

$N_2 \sin 60° - 0.2\ N_2 \sin 30° - Q = 0$

$Q = 0.766\ N_2$ ...(i)

Putting in wedge

$\sum F_x = 0$

$0.2\ N_2 \cos 30° + N_2 \cos 60° - P = 0$

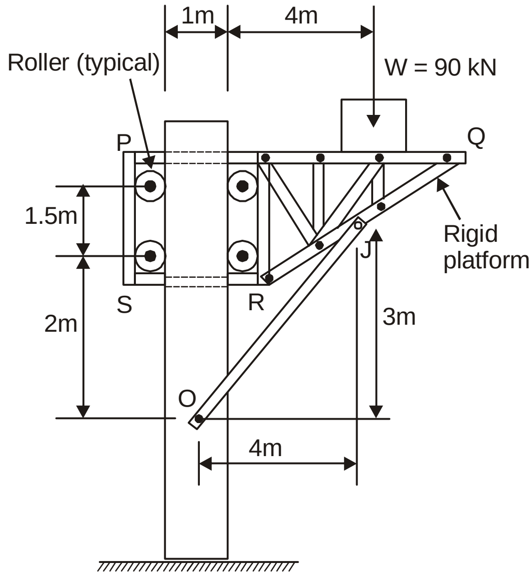
$$P = 0.67\ N_2$$

or $$P = 0.67 \times \frac{Q}{0.766}$$

$$= 0.875\ Q = 0.9Q$$

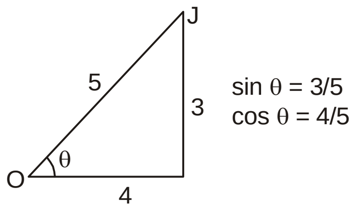
$\therefore \quad \alpha = 0.9$

5. (a) Let the bar OJ is inclined at 'θ' with horizontal.



According to the assembly, the weight W = 90 kN must be equal to vertical component of force in member 'OJ'.

Hence $F_{OJ} \sin\theta = 90$ kN



$$\Rightarrow \quad F_{OJ} = \frac{90}{0.6}$$

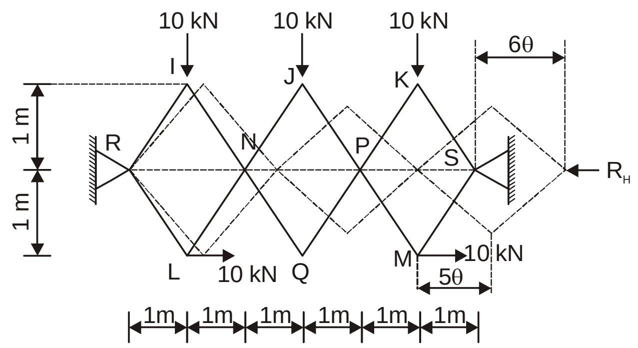
$$\Rightarrow \quad \boxed{F_{OJ} = 150\,kN}$$

Now at 'O', horizontal component of reaction,

$H_O = F_{OJ} \cos\theta = 150 \times 0.8$

$$\Rightarrow \quad \boxed{H_O = 120\ kN}$$

6. (a)



Let us give angular displacement to members RI and RL an amount 'θ' as shown.

Due to which the resulting displacements are