Question Paper

Exam Date & Time: 26-Dec-2018 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

FIRST SEMESTER B.TECH END SEMESTER MAKE-UP EXAMINATIONS, DECEMBER 2018

Mechanics of Solids [CIE 1051 - 2018 -PHY]

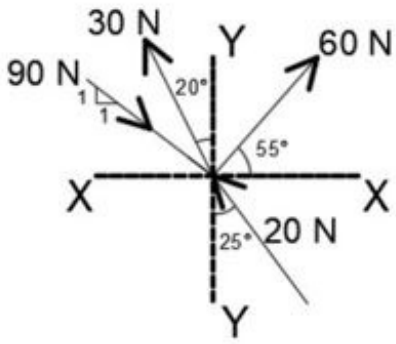
Marks: 50 **Duration: 180 mins.**

A

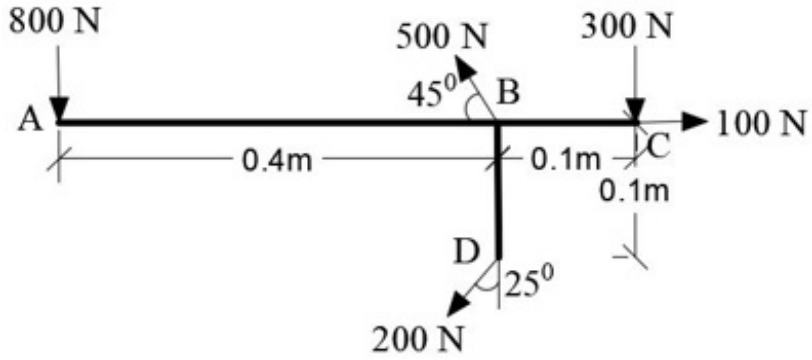
Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

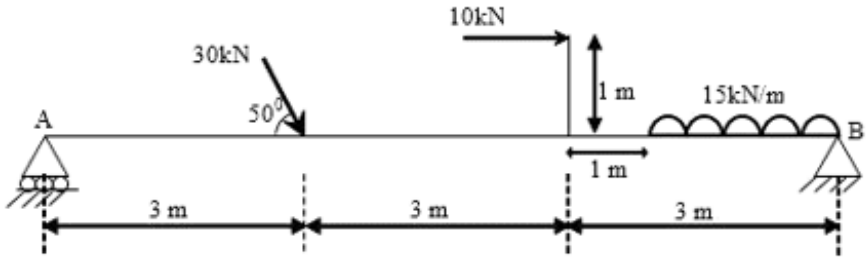
1) A) Determine the resultant of force system comprising of four forces shown in the figure. (2)



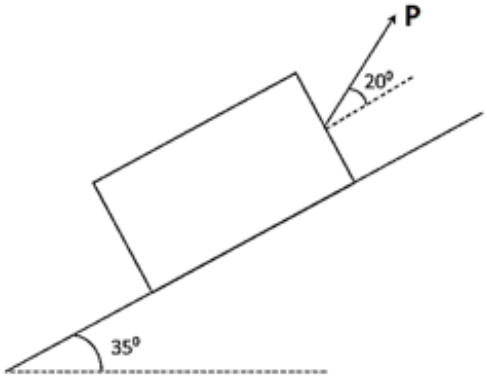
B) A bracket ABCD is subjected to a system of coplanar forces as shown in the figure. Determine the magnitude of resultant and locate it w.r.t A. (4)



C) Determine the reactions at the supports A and B for the beam loaded as shown in the figure. (4)

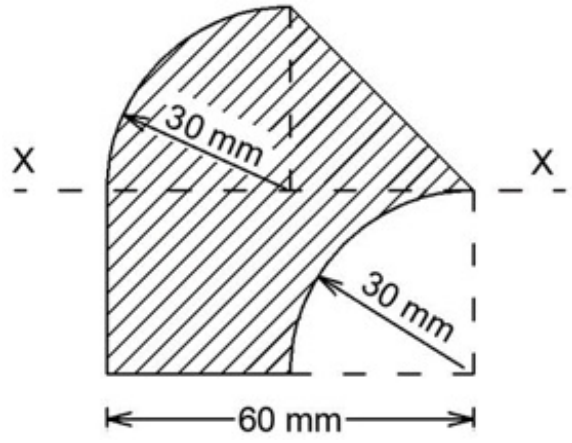


2) A) A block weighing 200 kN is resting on an inclined plane and is acted upon by force P as shown in the figure. If the coefficient of friction between the inclined plane and block is 0.3, calculate force P required to impend the block up the plane. (3)



B) Obtain the relationship between angle of limiting friction and angle of repose. (2)

C) Determine the second moment of area for the shaded area shown in the figure w.r.t given axis X-X. (5)

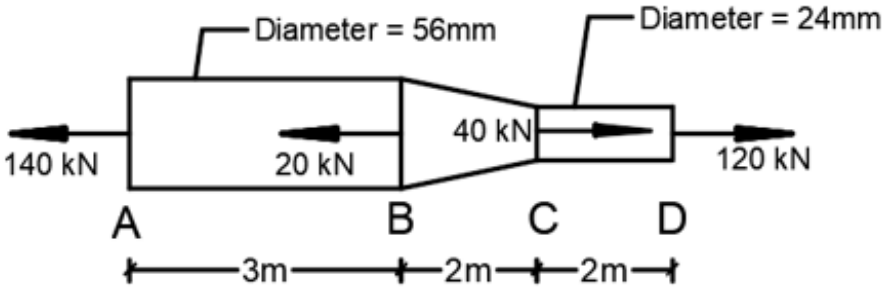


3) A) State and prove parallel axis theorem to obtain second moment of area w.r.t any axis parallel to centroidal axis. (2)

B) Obtain the centroid for right angled triangle with respect to its base from first principle. (3)

C) (5)

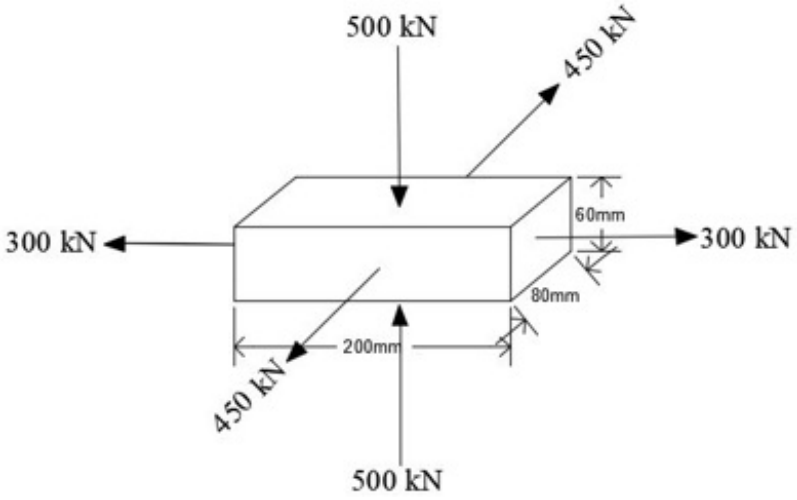
A composite circular bar of total length 7m is subjected to axial loads as shown in the figure. Determine the stress and deformation in portion AB, BC and CD. Also calculate the total deformation for the designated conditions. Take E = 210 GPa for sections AB and CD; E = 90 GPa for section BC.



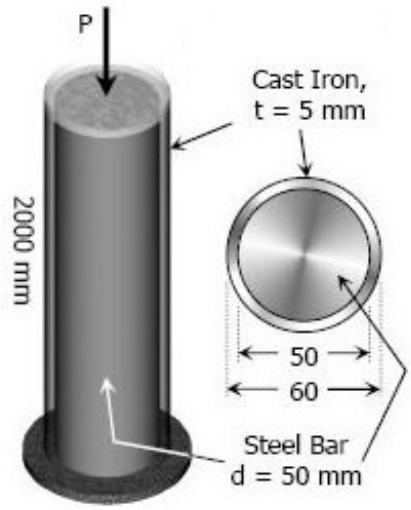
4) A boiler of 1000 mm internal diameter is subjected to an internal fluid pressure of 1.5 MPa. Wall thickness of the boiler is such that the safe maximum tensile stress of 30 MPa is developed. Calculate circumferential, longitudinal and volumetric strains in the boiler wall. Take E = 210 GPa and μ = 0.28. (3)

A)

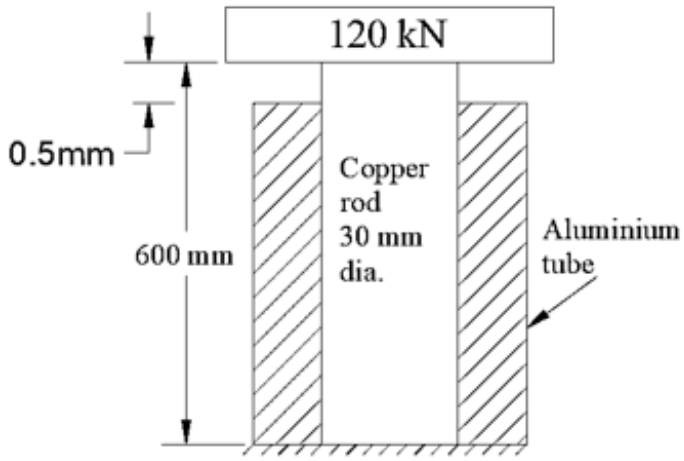
B) A rectangular bar of cross section (80mm X 60mm) is 200mm long. It is loaded with normal forces as shown in the figure. Calculate change in length, breadth, thickness and volume. Take E = 205 GPa and μ = 0.3. (5)



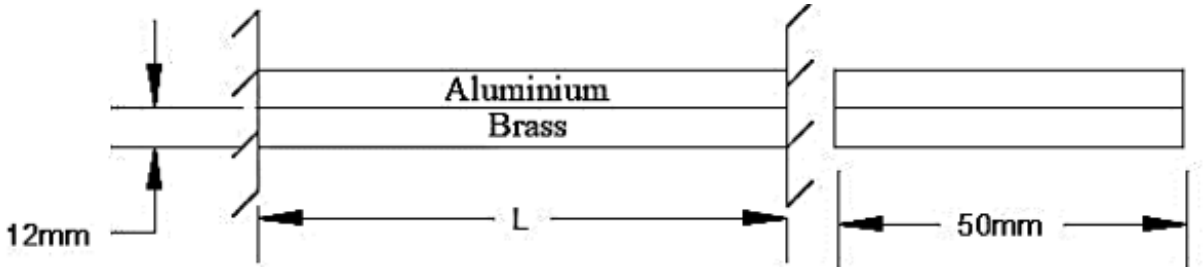
C) A steel bar 50 mm in diameter and 2 m long is surrounded by a shell of a cast iron 5 mm thick as shown in the figure. Compute the load that will compress the combined bar to a total of 0.8 mm in the length of 2 m, if load resisted by cast iron is 34.56kN. For steel, E = 200 GPa, and for cast iron, E = 100 GPa. (2)



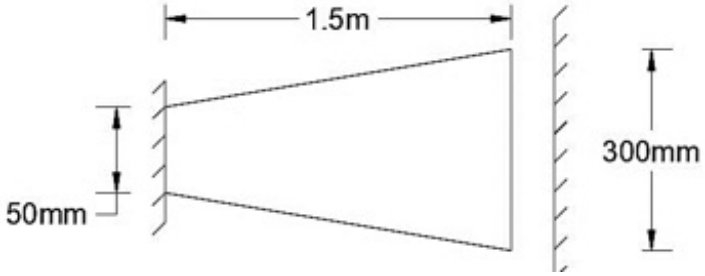
5) A) A composite member made up of an aluminium tube and copper rod supports a load of 120 kN through a rigid plate. There is a gap of 0.5 mm between aluminium tube and the support as shown in the figure. The thickness of aluminium tube is 3 mm. What are the stresses developed in each of the materials of the composite bar? Consider E_{copper} = 110 GPa and $E_{aluminium}$ = 69 GPa. (5)



B) A compound bar of length L is made of two bars (aluminium and brass), each of which has cross section (50 mm X 12 mm). The bars are fastened together at the ends as shown in the figure. $E_{aluminium}$ = 70 GN/m^2 and E_{brass} = 100 GN/m^2. If the bars are initially fastened at 18°C and the temperature of the whole assembly is then raised to 50°C, determine the stresses developed in brass and aluminium. Take coefficients of expansion for brass and aluminium as 18 X 10^{-6}/°C and 22 X 10^{-6}/°C respectively. (3)



C) A tapered flat of uniform thickness 10mm throughout the length has width varying from 50mm to 300mm. The bar is placed between two supports as shown in the figure. If the temperature of the bar is raised by 70°C, calculate the maximum stress developed in the bar if a gap provided between the bar and one of the supports is of 1mm. E = 200 GN/m^2; $\alpha = 12X10^{-6}$/ °C. (2)



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Question Paper

Exam Date & Time: 23-Nov-2018 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
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FIRST SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV 2018

Mechanics of Solids [CIE 1051 - 2018 -PHY]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

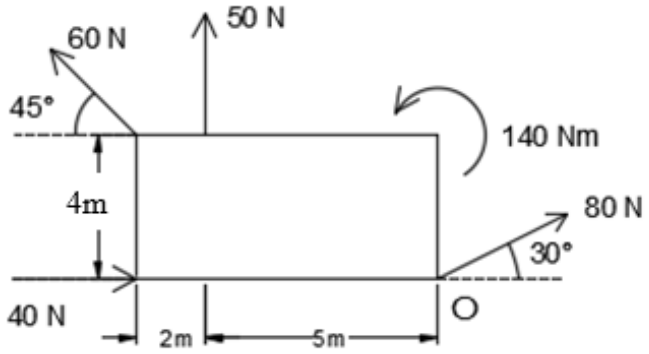
Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) (2)

A) Define:
(i) Resultant of a force system (ii) Collinear forces (iii) Composition of forces (iv) Rigid body

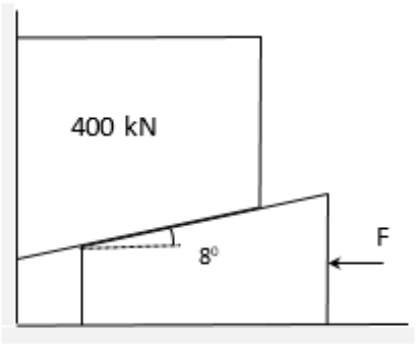
B) (4)

Find magnitude, direction and position of a resultant force for a system of forces shown in the figure with respect to 'O'.



C) (4)

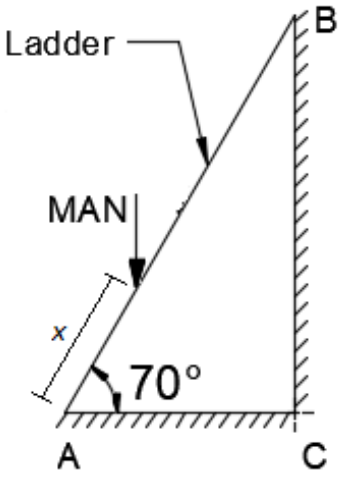
A block of weight 400 kN is lifted by a wedge as shown in the figure. Calculate force 'F' required to rise the block. Consider angle of limiting friction as 19Â° at all contact surfaces.



2) (3)

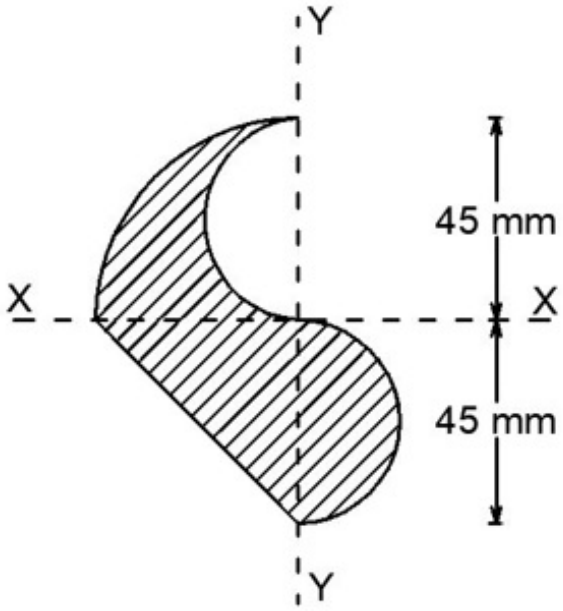
A) A man weighing 750 N starts to climb 7m long ladder weighing 250 N. Determine distance 'x' indicated in the

figure when the ladder starts to slip. The coefficient of friction for all rubbing faces is 0.30.



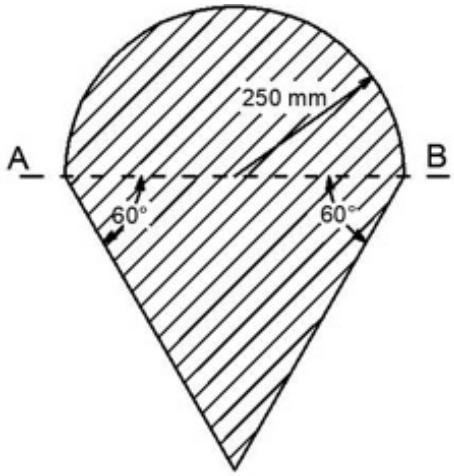
B) Illustrate with neat sketches: (i) Free body diagram (ii) Space diagram (2)

C) Locate the centroid of shaded area with respect to the axes shown in the figure. (5)



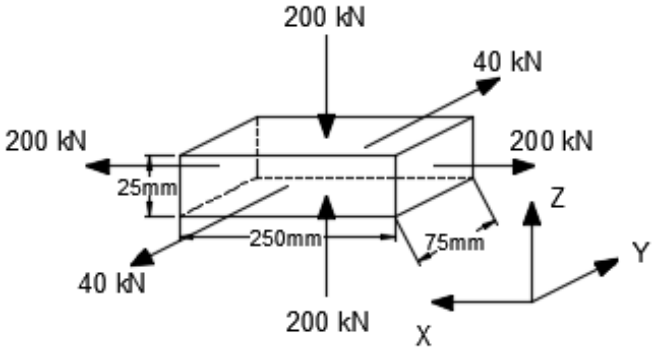
3) Determine moment of inertia of the shaded area shown in the figure with respect to a given reference axis AB . (2)

A)



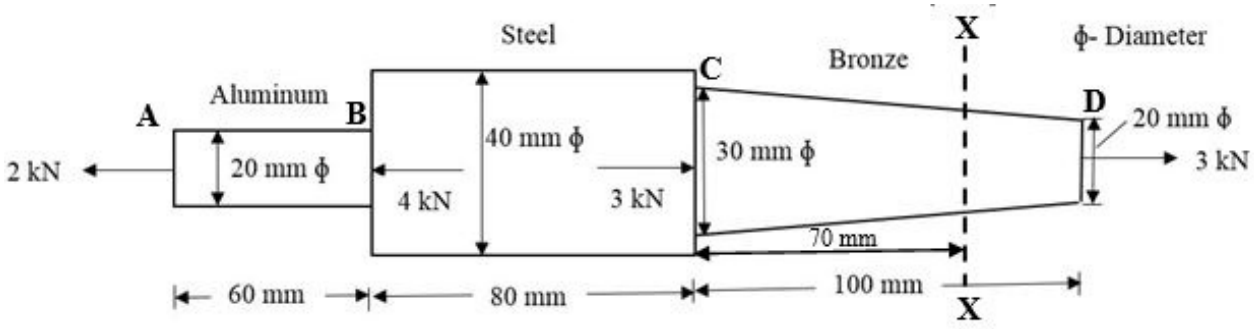
B) Derive an expression to calculate moment of inertia of triangular area with respect to its base. (3)

C) A rectangular bar (250mm X 75mm X 25mm) is loaded as shown in the figure. Determine (i) change in length, (ii) change in breadth, (iii) change in thickness and (iv) change in volume. What axial longitudinal load alone can produce the same longitudinal strain as in the case (i)? Take E = 200GPa and μ = 0.3. (5)



4) A) A thin cylinder 1000mm diameter, 10mm thick and 5m long is subjected to an internal fluid pressure of 3 N/mm^2. If E = 200GPa and μ = 0.3, determine (i) the change in length, (ii) change in diameter and (iii) change in volume. (3)

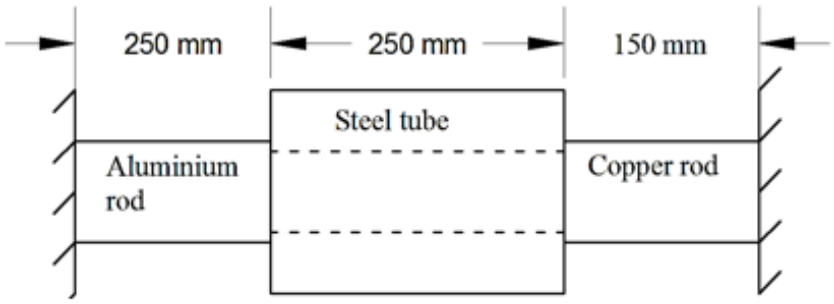
B) A composite circular bar consists of a steel section rigidly fastened between aluminium and bronze sections as shown in the figure. Axial loads are applied at the positions indicated. (5)
(i) Determine stresses in sections AB, BC and at section X-X of the tapered bar CD.
(ii) Calculate the total deformation.
Take $E_{aluminium}$=70 GPa, E_{steel}=200 GPa, E_{bronze}=90GPa.



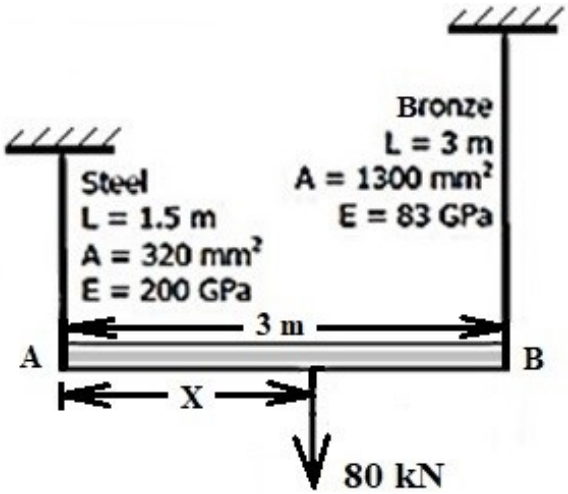
C) A metal rod of 12 m long is kept between two supports with a gap between rod and supports. If the stress developed due to temperature increment of 90Â°C is 75 MPa, what is the gap left between the rod and the supports? Young's modulus of the material is 110 GPa and coefficient of thermal expansion is $19x10^{-6}$/Â°C. (2)

5) A steel tube of internal diameter 16 mm and external diameter of 25 mm is rigidly fastened between aluminium and copper rods of 20 mm diameter each as shown in the figure. If the temperature of the system is raised by 30Â°C, calculate the nature and magnitude of the stresses developed: $E_{aluminium}$ = 70 GPa; E_{steel} = 200 GPa; E_{copper} = 110 GPa and $\alpha_{aluminium}$ = 24 x 10^{-6}/Â°C; α_{steel} = 13 x 10^{-6}/Â°C; α_{copper} = 17 x 10^{-6}/Â°C. (5)

A)



B) A rigid bar AB of 3m long is suspended by two vertical rods at its ends A and B and hangs in a horizontal position as shown in the figure. At what distance 'x' from A, a vertical load P = 80 kN may be applied for the rigid bar to remain horizontal. Neglect self-weight of the rigid bar. (3)



C) Calculate the safe load that can be supported by a reinforced concrete circular short column of 300 mm diameter, if the stress developed in concrete is 15 MPa. Take E_{Steel} = (14.3 $E_{Concrete}$). Given, total area of steel provided = 6 bars of 25mm diameter each. (2)

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MANIPAL INSTITUTE OF TECHNOLOGY

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II SEMESTER B.TECH

END SEMESTER EXAMINATIONS, JUN 2019

SUBJECT: MECHANICS OF SOLIDS [CIE 1051]

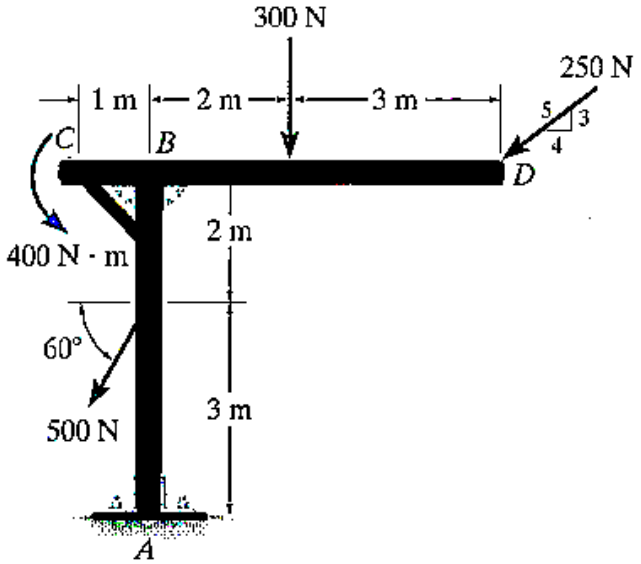
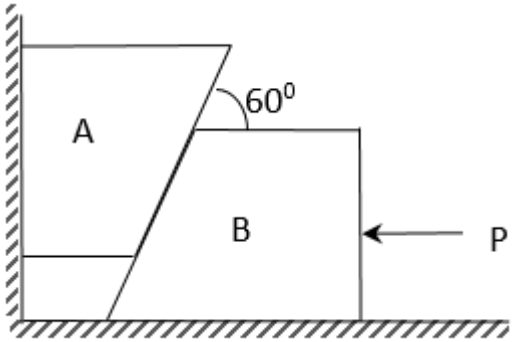
REVISED CREDIT SYSTEM

(/06/2019)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

	Questions	Marks	CO
1A.	Define couple and state any three characteristics of it.	**02**	**01**
1B.	Locate the resultant of a force system shown in the figure with respect to A. 	**04**	**01**
1C.	Block A of weight 500 N and block B of weight 1000 N are positioned as shown in the figure. Find minimum value of force P required to keep the system in equilibrium. Take coefficient of friction between floor and block as 0.25, between wall and block as 0.3 and between blocks as 0.2. 	**04**	**02**

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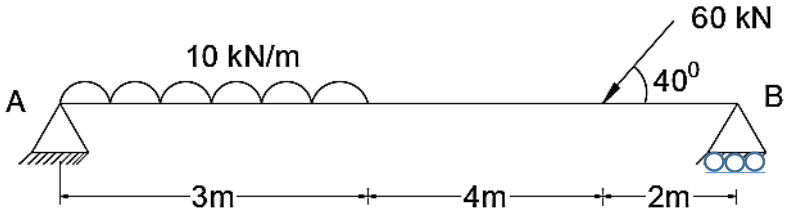
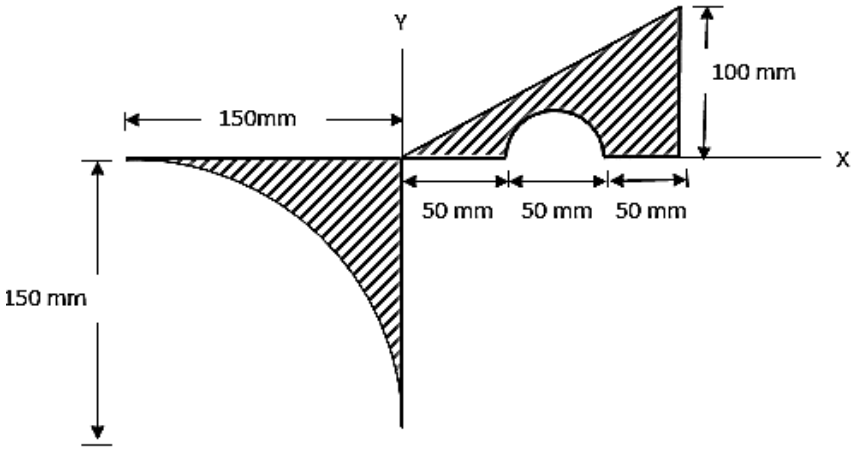
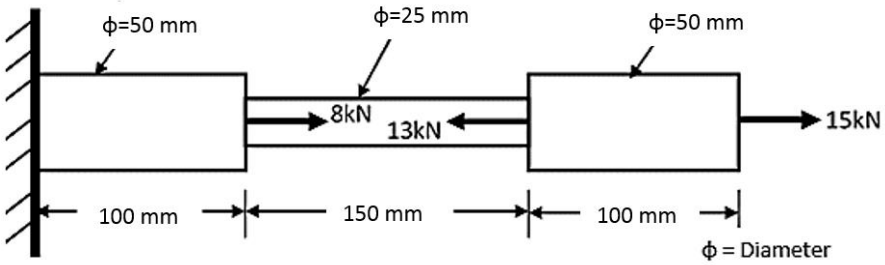
2A.	State any four laws of dry friction.	**02**	**02**
2B.	Determine the support reactions for the beam shown in the figure. 	**03**	**02**
2C.	Locate the centroid of a shaded area w.r.t. to X axis shown in the figure. 	**05**	**03**
3A.	Determine the moment of inertia for quarter circular area of radius 'R' about its base by direct integration.	**03**	**03**
3B.	A stepped rod of circular section is axially loaded at different points as shown in the figure. Calculate modulus of elasticity, if the total extension of the bar is 0.01mm. 	**04**	**04**
3C.	Draw typical stress-strain curve for ductile material subjected to tensile test and mark salient points.	**03**	**04**
4A.	A rectangular bar of cross section (100 mm × 50 mm) is 250 mm long. It is loaded with normal forces as shown in the figure. Calculate change in length, breadth, thickness and volume. Take E = 180 GPa and μ = 0.35.	**04**	**04**

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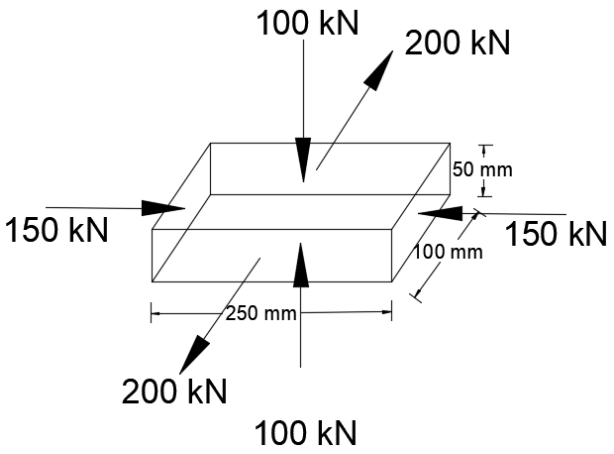
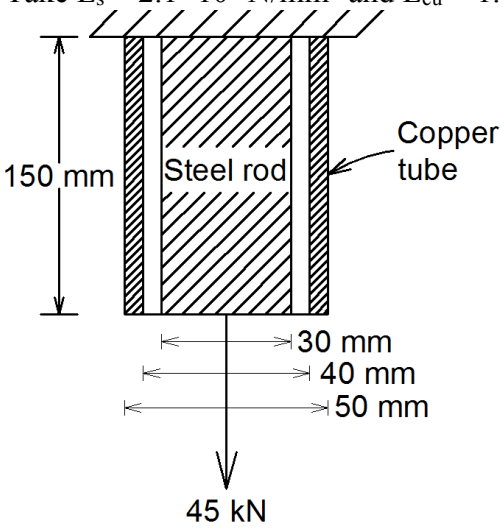
			
4B.	A thin cylinder of 1 m long has an internal diameter 230 mm and 5 mm thick wall. The change in internal volume is 12.0 x10^{-6} m^3 when filled with a liquid at pressure 'p'. If E = 200 GN/m^2 and μ= 0.25, determine the hoop and longitudinal stresses.	**03**	**04**
4C.	Show that in a state of simple shear for a square element of unit thickness, magnitude of diagonal normal stress is equal to the magnitude of applied shear stress.	**03**	**04**
5A.	A compound bar is made up of a steel rod of 30 mm diameter enclosed centrally in a hollow copper tube of external diameter 50 mm and internal diameter 40 mm as shown in the figure. The compound bar is fastened rigidly at the ends. The bar is now subjected to an axial pull of 45 kN. If the length of composite bar is 150 mm, determine: (i) The stresses developed in the rod and tube (ii) Deformation of each material Take $E_s = 2.1\times10^5$ N/mm^2 and $E_{cu} = 1.1 \times 10^5$ N/mm^2. 	**04**	**05**
5B.	A compound bar is made up of steel and aluminium and is held between two rigid supports as shown in the figure. The bars are stress free at a temperature of 42°C. What will be the stresses in two materials when the temperature increases to 66°C. Take E_{al} = 70 GPa, E_s = 200 GPa, $\alpha_{al} = 24 \times 10^{-6}$ /°C, $\alpha_s = 12 \times 10^{-6}$ /°C, A_s = 160 mm^2 and A_{al} = 240 mm^2.	**03**	**05**

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	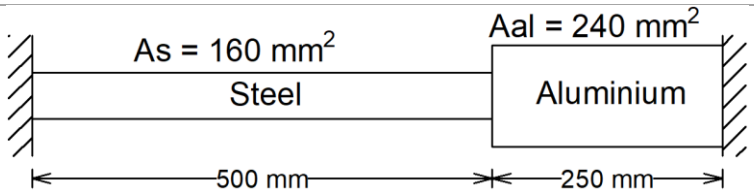		
5C.	A 1m long uniform circular bar section is rigidly fixed between two supports at its ends. If the temperature is raised by 45°C, calculate the maximum stress in the bar if one of the support yields by 0.08mm. Take E= 200 GPa, $\alpha=12\times10^{-6}$/°C.	**03**	**05**

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II SEMESTER B.TECH

END SEMESTER EXAMINATIONS, APR/MAY 2019

SUBJECT: MECHANICS OF SOLIDS [CIE 1051]

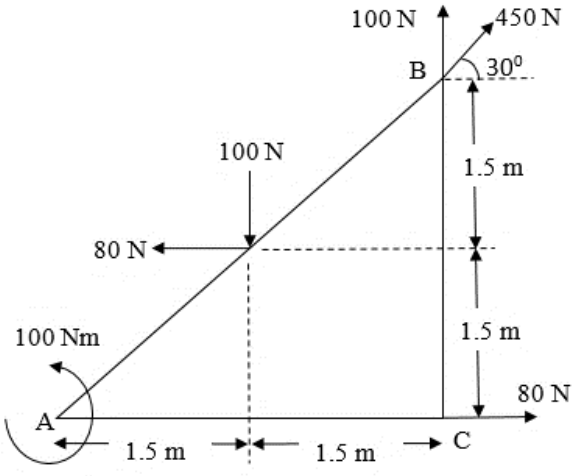
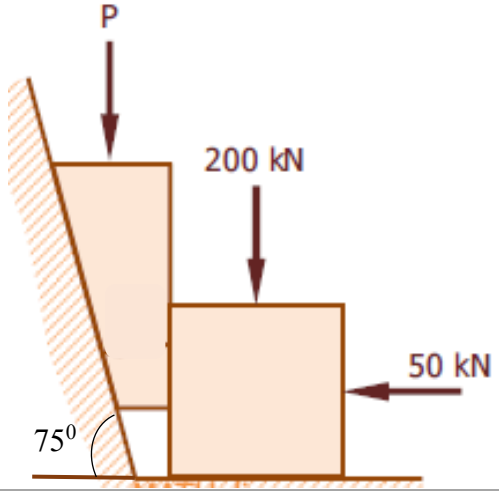
REVISED CREDIT SYSTEM

(06/04/2019)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

	Questions	Marks	CO
1A.	Explain the following and illustrate with neat sketches a) Principle of transmissibility b) Varignon's theorem	**02**	**01**
1B.	Locate the resultant of a force system shown in the figure with respect to C. 	**04**	**01**
1C.	Determine the minimum value of force P required to drive the wedge shown in the figure. The angle of friction for all surfaces in contact is 15°. 	**04**	**02**

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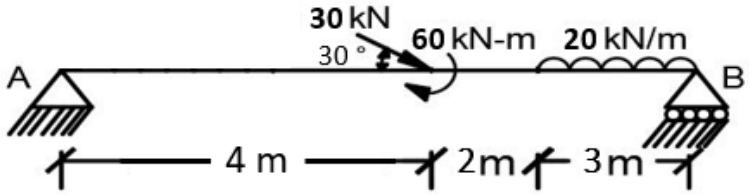
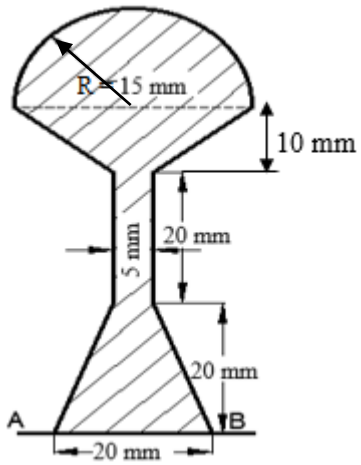
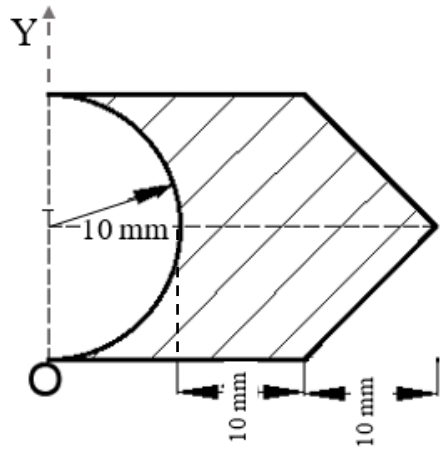
2A.	Define the following terms and illustrate with neat sketches i) Free body diagram ii) Static friction	**02**	**02**
2B.	Determine the support reactions for the beam shown in the Figure. 	**03**	**02**
2C.	Determine moment of inertia about an axis AB shown in the figure. 	**05**	**03**
3A.	Determine the centroid of a hatched area with respect to axis OY shown. 	**03**	**03**
3B.	Derive an expression for elongation of a tapered bar subjected to an axial tensile load 'P'. The flat has uniform thickness 't' and width varies uniformly from b_1 to b_2 ($b_1 < b_2$) along its length L.	**04**	**04**
3C.	The diameter of a specimen is found to reduce by 0.004 mm when subjected to a tensile force of 19 kN. The initial diameter of the specimen is 20 mm and modulus of rigidity is 40 GPa. Determine the values of E and μ.	**03**	**04**

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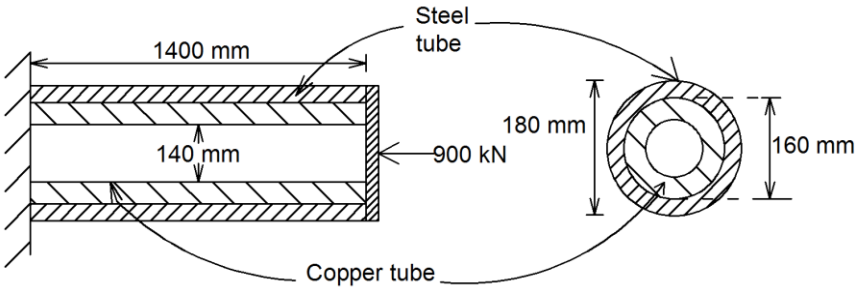
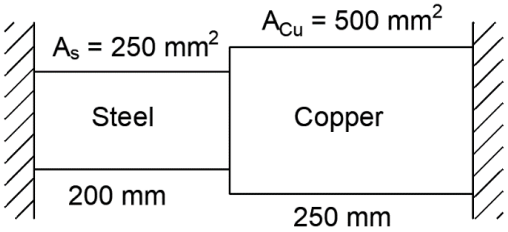
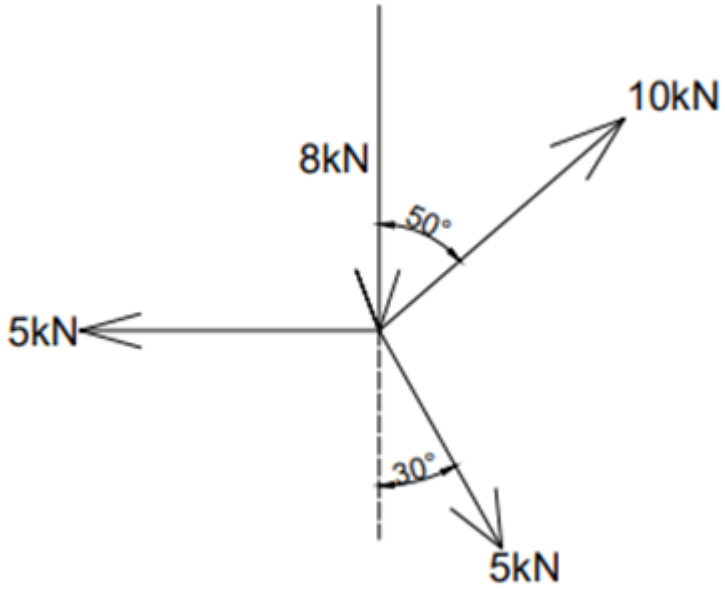
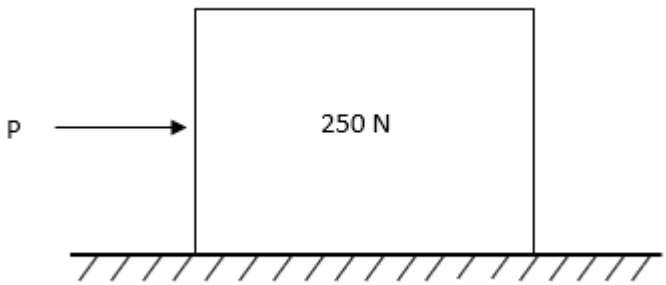
4A.	A bar of 200 mm long and 20 mm square cross section is subjected to an axial compressive load of 50 kN in longitudinal direction. The modulus of elasticity of the material is 150 GPa and Poisson's ratio is 0.30. Find the change in length, if expansions in lateral directions are prevented by the application of uniform lateral external pressure of suitable intensity.	**04**	**04**
4B.	A thin cylinder of 75 mm internal diameter, 250 mm long with walls 2.5 mm thick is subjected to an internal pressure of 7 MN/m^2. Determine the change in internal diameter, change in length, and change in volume. Take E = 200 GN/m^2, $\mu = 0.3$.	**03**	**04**
4C.	Obtain the relationship between bulk modulus (K) and modulus of elasticity (E).	**03**	**04**
5A.	A compound tube consists of a copper tube 160 mm external diameter and 140 mm internal diameter is enclosed inside a steel tube of 180 mm external diameter and 160 mm internal diameter as shown. If the compound tube carries an axial load of 900 kN, find the stresses developed and the deformation in each tube. Take $E_s = 2 \times 10^5$ N/mm^2 and $E_{cu} = 1 \times 10^5$ N/mm^2 	**04**	**05**
5B.	A bar is composed of two segments as shown in figure. Find the stress developed in each material when the temperature is raised by 60°C when the supports are perfectly rigid. Take $E_s = 200$ GPa, $E_{Cu} = 100$ GPa, $\alpha_s = 12 \times 10^{-6}$/°C, $\alpha_{cu} = 18 \times 10^{-6}$/°C. 	**04**	**05**
5C.	A rail track is to be constructed using steel rails of 20 m long. What minimum expansion gap is to be provided so that thermal stresses in rails should not exceed 70 N/mm^2 when the rails experience maximum rise in temperature of 40^0C during peak hours? Given $\alpha = 15 \times 10^{-6}$/°C and E = 210 GPa.	**02**	**05**

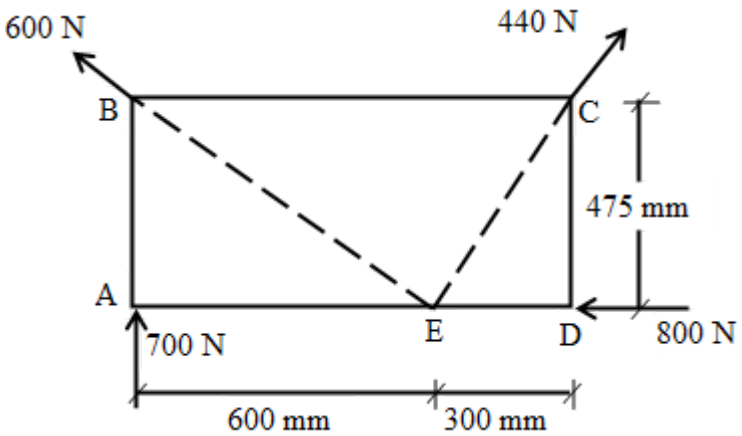


12) A 250 N block is resting on a rough horizontal surface for which the coefficient of friction is 0.30. Determine the force P required, if applied to the block horizontally, to cause motion to impend as shown in figure.



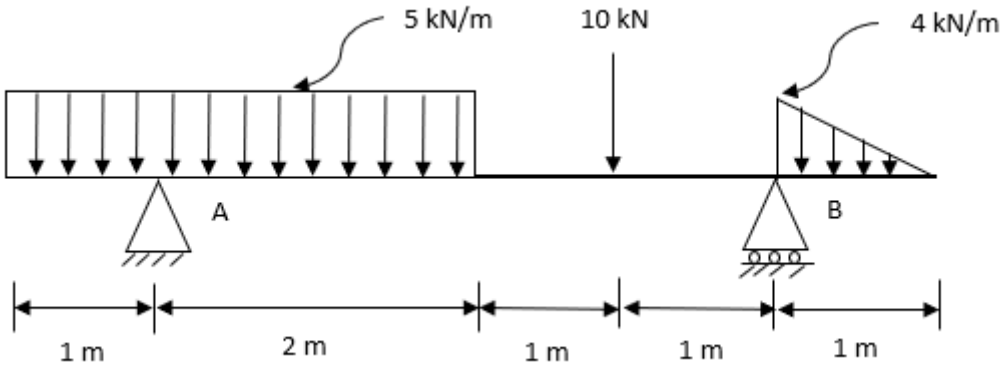
(2)

13) Determine the magnitude, direction, and position of the resultant force of the system of forces shown in the figure with respect to 'E'.



(3)

14) Determine the support reactions for the beam as shown in figure. (3)



stress is proportional to strain within elastic limit | the failure of the specimen is sudden without any prior indication. | the failure is in the form of a cup and cone fracture. | a stout (short) specimen is used for the test.

7) The centroidal axis of a quarter circle of radius 50 mm lies at a distance of _____ from its base. (0.5)

21.22 mm | 42.44 mm | 10.61 mm | 117.81 mm

8) The polar moment of inertia of a circle of diameter 'D' about its centroid is, (0.5)

$\pi D^4/64$ | $\pi D^4/32$ | $\pi D^4/8$ | $\pi D^4/32$

9) The radius of gyration of a quarter circle of radius 'r' about an axis passing through horizontal centroidal axis is, (0.5)

0.11r | 0.37r | 0.26r | 0.055r

10) The moment of inertia of an Isosceles triangle of 60 mm base and 60 mm height about its vertical centroidal axis is, (0.5)

108×10^3 mm^4 | 130×10^3 mm^4 | 216×10^3 mm^4 | 270×10^3 mm^4

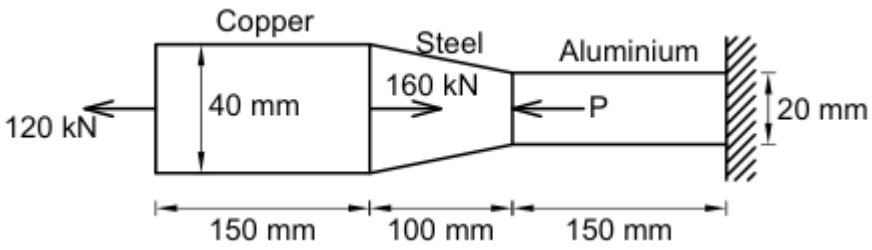
DESCRIPTIVE

Answer all the questions.

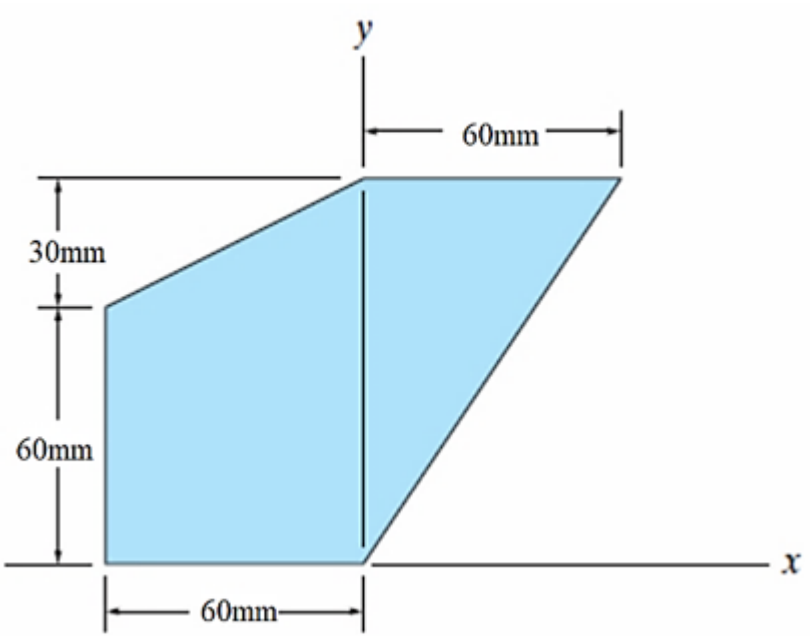
11) A tapered bar of certain material has a length 100 mm, a diameter of 40 mm at one end and 20 mm at the other end. When this bar is subjected to a force of 200 kN, a deformation of 0.16 mm was observed. By keeping the length, loading conditions, and deformation same, determine the diameter of another bar of uniform circular cross section made up of same material. (2)

12) State and prove parallel axis theorem. (2)

13) A composite bar of circular section consists of a steel section rigidly fastened between an Aluminium section and a copper section as shown in the figure. The axial loads are applied at the positions indicated. Determine the value of 'P' such that the deformation in Aluminium is zero. Also determine the total deformation of the composite bar. Given E_{Cu} = 100 GPa, E_{Al} = 70 GPa, E_S = 200 GPa. (3)



14) Locate the centroid of shaded area shown in the figure w.r.t 'x' and 'y' axes. (3)



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