SCAD ENGINEERING COLLEGE

QUESTION BANK

DEPARTMENT : CIVIL **SEMESTER : III**

SUBJECT CODE: CE6302 **SUBJECT NAME: MECHANICS OF SOLIDS**

UNIT 1- STRESS AND STRAIN

PART – A (2 Marks)

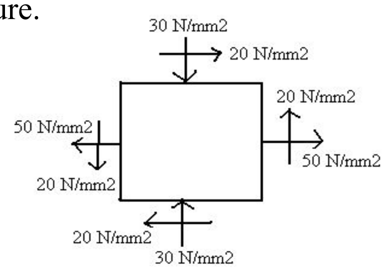
1. Distinguish between the following: Stress & Strain, Force & Stress, Tensile stress & Compressive stress.
2. Define modular ratio, Poisson's ratio & Hook's Law.
3. Write the relationship between bulk modulus, rigidity modulus and Poisson's ratio.
4. Draw stress – strain diagram for mild steel, brittle material and a ductile material and indicate salient points.
5. If the linear strain in a steel specimen is 0.001 and the lateral strain is 0.0003, find the Poisson's ratio.
6. What is the principle of Super position? Explain its uses.
7. Define the terms: Principal planes and Principal stresses. Also explain their uses.
8. Write a note on Mohr's circle of stresses.
9. Define stress and strain. What are the different types of stresses and strains? Define the terms: Elasticity, Elastic limit, Young's Modulus and Modulus of rigidity.
10. Draw the Mohr's circle for a state of pure shear and indicate the principal stresses.
11. What type of stress will be induced in a bar when the ends are restrained and subjected to (a) rise in temperature (b) fall in temperature?
12. Explain the significance of Mohr's circle and its uses.
13. Define working stress & allowable stress.
14. State whether the following statements are true or false.

    (a) On the planes having maximum or minimum principal stresses there will be minimum tangential stress.

    (b) Shear stresses on mutually perpendicular planes are numerically equal.
15. Define the term 'obliquity' and how it is determined.
16. What do you mean by rigid bodies and deformable solids?
17. What do you understand by the terms surface forces and body forces?
18. Write the relationship between 3 elastic constants.
19. Define lateral strain lateral stress.
20. Define Factor of safety.

PART-B (16 Marks)

1. Determine the direction of principal plane, normal stresses and tangential stress of the strained material as shown in figure.



2. The normal stresses acting on two perpendicular planes at a point in a strained material are 70 MN/ m^2 tensile, 35 MN/ m^2 compressive. In addition, shear stress of 40 N/mm^2 act on these planes. Calculate the following:

(i).The magnitude of the principle stresses

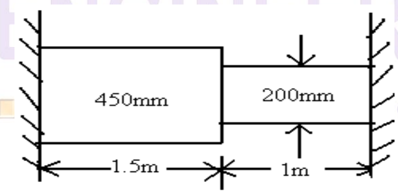
(ii).The direction of the principal planes

(iii).The magnitude of the maximum shear stress.

3. A steel tube 50mm external diameter 5mm thick encloses centrally a copper bar of 30 mm diameter. The bar and tube are rigidly connected together at the end at a temperature of 30^oC.

The composite bar is subjected to an axial compressive load of 60kN and the temperature is raised to 150^oC. Determine the stresses in the steel tube and copper rod $\alpha_s = 12x10^{-6}/^oC$, $\alpha_{cu} = 18x10^{-6}/^oC$, E_s = 200 GPa, E_{cu} = 100 GPa.

4. A bar of non uniform diameter, as shown in figure is rigidly fixed. There is no expansion of the ends and there is no stress in the bar at a temperature of 22^oC. If the temperature of the bar be raised to 45^oC, find the forces applied by the rigid walls on the bar. MOE and coefficient of thermal expansion for the materials are 200 GN/m^2 and $11.7x10^{-6}/^oC$ respectively. Assume no lateral buckling of the bar.



5. A body is subjected to direct stresses in two mutually perpendicular directions accompanied by a simple shear stress. Draw the Mohr's circle of stresses and explain how you will obtain the principal stresses and principal planes.

6. The normal stresses acting on two perpendicular planes at a point in a strained material are 100 MN/ m^2 tensile, 45 MN/ m^2 compressive. In addition, shear stress of 50 N/mm^2 act on these

planes. Calculate the following:

(i).The magnitude of the principle stresses

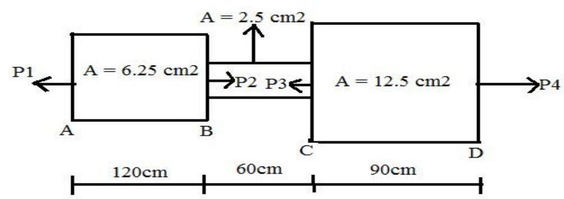
(ii).The direction of the principal planes

(iii).The magnitude of the maximum shear stress.

7. A M.S bar of 50mm square in size and 150mm long is subjected to an axial thrust of 200kN. Half the lateral strain is prevented by the application of uniform external pressure of certain intensity. If E = 200 GPa and Poisson's ratio 0.3. Calculate the change in the length of the bar.

8. An element in a stressed material has tensile stress of 500 N/mm^2 and compressive stress of 350 N/mm^2 acting on two mutually perpendicular planes and equal shear stresses of 100 N/mm^2 on these planes. Find the principal stresses and its planes. Find the plane of maximum shear stress and its plane.

9. A member ABCD is subjected to point loads P1, P2, P3 and P4 as shown in fig. Calculate the force P2 necessary for equilibrium if P1=4500kg, P3=45,000kg and P4=13,000kg. Determine the total elongation of the member, assuming E to be $2.10X10^6$ kg/cm^2.

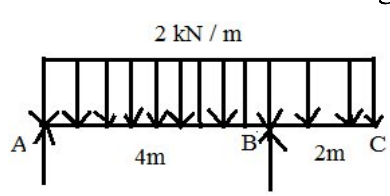


10. A solid circular bar of diameter 20mm when subjected to an axial tensile load of 40 KN, the reduction in diameter of the rod was observed as $6.4x10^{-3}$ mm. The bulk modulus of the material of the bar is 67 GPa. Determine the following. a) Young modulus, b) Poisson's ratio, c) Modulus of rigidity, d) Change in length per meter and e) Change in volume of the bar per meter length.

UNIT 2 – SHEAR AND BENDING IN BEAMS

PART – A (2 Marks)

1. Define beam and point of contra flexure.
2. Define and explain the following terms: Shear force, Bending moment, Shear force diagram & bending moment diagram.
3. What are the sign conventions for shear force & bending moment in general?
4. Draw the S.F. & B.M. diagrams for simply supported beam of length L carrying a point load W at its middle point.
5. What do you mean by point of contra flexure? Is the point of contra flexure and point of inflexion different?
6. Sketch any 2 types of supports used for a beam indicating the reactions in each case.
7. A cantilever beam of span 4m is subjected to a udl of 2 kN/m over its entire length. Sketch the bending moment diagram for the beam.
8. Draw the pattern of the S.F.D. for the beam shown in the figure.



9. Give the relationship between B.M. & S.F. and rate of loading in a beam.
10. How do you locate the point of maximum bending moment?

11. What do you understand by neutral axis & moment of resistance? How do you locate Neutral axis?

12. What do you mean by section modulus? Find an expression for section modulus for rectangular, circular & hollow circular sections.

13. Define and explain the terms: Modular ratio, flitched beams & Equivalent sections.

14. Define shear flow and Write down the bending equation.

15. (a).The plane of load should contain of load should contain one of the principal axes of inertia, so that the neutral axis is perpendicular to the plane of load –true or false.

(b).In the theory of simple bending neutral axis is the centroidal axis perpendicular the plane of load – true or false.

16. State the theory of simple bending and also assumptions made in the theory on bending?

17. A beam subjected to a bending stress of $5N/mm^2$ and the section modulus is 3530 cm^3. What is the moment of resistance of the beam?

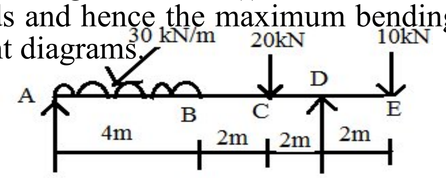
18. How would you find the bending stress in unsymmetrical sections?

19. What do you understand by the assumption, plane section remain plane even after the application of load?

20. Draw the bending stress distribution for a symmetrical I section.

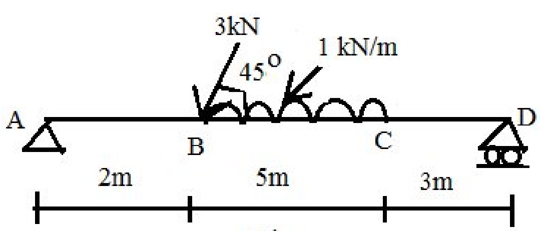
PART-B (16 Marks)

1. For the loaded beam shown in Fig determine (i) The reaction at each support (ii) The bending moment under the loads and hence the maximum bending moment. Also draw the shear force and bending moment diagrams.



Fig

2. Draw the shear force and bending moment diagram for the beam shown in Fig. Indicate maximum positive bending moment and its location.

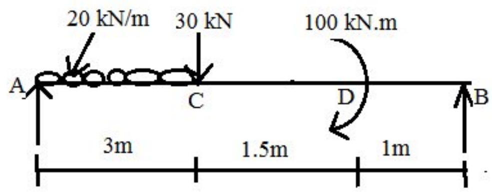


Fig

3. A beam 6m long and simply supported at each end has a uniformly distributed load of 800

N/m extending from the left end to a point 2 m away. There is also a clockwise couple of 1500 Nm. applied at the centre of the beam AB. Draw the shear force and bending moment diagrams for the beam and find the maximum bending moment.

4. Draw shear force and bending moment diagram for the beam shown in Fig.



5. A cantilever of length 4m carries a of 3KN/m run over the whole length and two point loads of 4KN and 2.5KN are place 1m and 2m respectively from the fixed end. Draw the shear force and BM diagram.

6. A T – section of a beam has the following dimensions width of the flange 100mm, overall depth 80mm, thickness of the web 10mm, thickness of flange 10mm. Determine the maximum bending stress in the beam, when the bending moment of 200 Nm is acting one of the section.

7. Two wooden planks 50mm x 150mm in section is used to form a Tee section as shown in fig. if a bending moment of 3400 Nm is applied with respect to the neutral axis. Find the extreme fibre stresses and the total tensile force.

8. A flitched beam consists of two timber joist 100mm wide and 240mm deep with a steel plate 180mm deep and 10mm thick placed symmetrically between the timber joists and well clamped. Determine

i) The maximum fibre stress when the maximum fibre stress in wood is 80 kg/cm^2.

ii) The combined moment of resistance if the modular ratio is 18.

9. A rectangular beam of width 100 mm and depth 200 mm is simply supported over a span of 6 m and carries a central concentrated load of 20 kN. Determine the maximum bending and shear stress in the beam and indicate where in the beam they occur. Plot the distribution of the stresses across the depth at any cross-section.

10. A rolled steel joist of section has the following dimension.

Flange width = 250 mm; Flange thickness = 25 mm

Overall depth = 800 mm; Web thickness = 12 mm

Calculate the safe 'UDL' per meter length of beam, if the beam, if the effective span is 8m and the maximum stress in steel is 100 N/mm^2.

UNIT 3- DEFLECTION

PART – A (2 Marks)

1. What are the methods for finding out the slope and deflection at a section?
2. Why moment method is more useful when compared with double integration?
3. What is a conjugated beam?

4. Draw the variation of shear stress for a Tee section?

5. Sketch the shear stress distribution for a circular section. Indicate also the layer at which maximum stress occurs?

6. A cantilever beam of span 'L' is subjected to a concentrated load 'w' at free end. What would be the maximum slope and deflection?

7. Relate the rate of loading, shear stress, bending moment, slope and deflection by integral equations?

8. What is a shear center?

9. Write the maximum value of deflection for a cantilever beam of length L, constant EI and carrying concentrated load W at the end?

10. State the two theorems in moment area method?

11. Write the differential equation of deflection of a bent beam?

12. What are the boundary conditions for a simply supported end?

13. When Macaulay's method is preferred?

14. What is meant by double integration method?

15. What is meant by deflection of beams?

16. When do you prefer Moment area method?

17. What is the slope at the support for a simply supported beam of length L, constant EI and carrying central concentrated load?

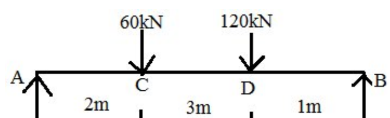
18. What is meant by determinate and indeterminate beams?

19. What are the values of slope and deflection for a cantilever beam of length 'L' subjected to Moment 'M' at the free end?

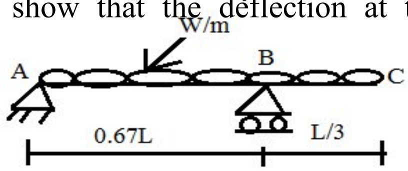
20. Write the relation between deflection of bending moment and flexural rigidity for a beam?

PART-B (16 Marks)

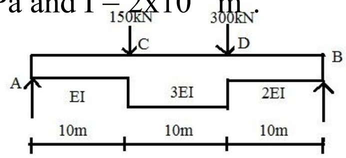
1. Obtain the deflection under the greater load for the beam shown in fig using the conjugate beam method.



2. For the beam shown in fig show that the deflection at the free end is $WL^4/684EI$. Use Macaulay's method.



3. Using conjugate beam method, obtain the slope and deflections at A, B, C and D of the beam shown in fig. take E = 200GPa and $I = 2x10^{-2}\ m^4$.



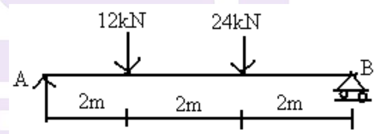
4. A simple beam of span 10m carries a udl of 3kN/m. The section of the beam is a T having a flange of 125x125mm and web 25x175mm. For the critical section obtain the shear stress at the neutral axis and at the junction of flange and the web. Also draw the shear stress distribution across the section.

5. A beam of channel section 120x60mm has a uniform thickness of 15mm. Draw the shear stress distribution for a vertical section where the shear force is 50kN. Find the ratio between the maximum and mean shear stress.

6. A beam AB of span 10m is simply supported at end A and B and is located as shown in figure. Take $E = 200x10^6\ kN/m^2$ and $I = 8.5x10^8\ mm^4$. Find the position and magnitude deflection using Macaulay's method.

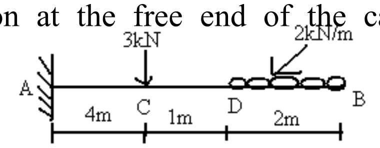
7. A cantilever of length 2.5m is loaded with an udl of 10 kN/m over a length 1.5m from the fixed end. Determine the slope and deflection at the free end. Determine the slope and deflection at the free end of the cantilever $L = 9500cm^4$, $E = 210\ GN / m^2$ using Moment area method.

8. Using double integration method, determine the deflection under the loads of the beam shown in fig.



9. A steel cantilever of 2.5m effective length carries a load of 25kN at its free end. If the deflection at the free end is not exceed 40mm. What must be the I value of the section of the cantilever. Take $E = 210\ GN/m^2$ using moment area method.

10. Find the slope and deflection at the free end of the cantilever shows in fig. Take $EI = 1x10^{10} kN/mm^2$.



UNIT 4- TORSION

PART – A (2 Marks)

1. What are the assumptions made in the theory of torsion?
2. Define torsion and polar modulus?
3. Write Torsional equation.
4. Why hollow circular shafts are preferred when compared to solid circular shafts?
5. Write the expression for power transmitted by a shaft.
6. The torque transmitted by a hollow shaft is given by ……..........
7. What is leaf spring?
8. A circular shaft is subjected to a torque of 10kNm. The power transmitted by the shaft is 209.33kW. Find the speed of shaft in revolution per minute.
9. Define spring Indeed and spring stiffness.
10. What is a stepped shaft?
11. Compare close coiled and open coiled springs under the action of an axial load.
12. What is the value of maximum shear stress in a close coiled helical spring subjected to an axial force?
13. State the types of stresses when a closed coiled spring is subjected to (i) axial load and (ii) axial twisting moment.
14. Write the equation for strain energy stored in a shaft due to torsion.
15. What is the equivalent bending moment for a shaft subjected to moment M and torsion T?
16. A shaft is having a diameter of 30mm. What is its polar moment of inertia?
17. How will you apply a moment to produce bending in a shaft?
18. How will you apply a moment to produce torque in a shaft?
19. Write the expression for vertical deflection of the closed coiled helical spring due to axial load W.
20. What is spring? State various types of springs.

PART-B (16 Marks)

1. i) Derive the torsion equation for a circular shaft of diameter‘d’ subjected to torque ‘T’.

   ii) Find the torque that can be transmitted by a thin tube 6 cm mean diameter and wall thickness 1 mm. the permissible shear stress is 6000 N/cm^2.
2. A close coiled helical spring is made of a round wire having ‘n’ turns and the mean coil radius R is 5 times the wire diameter. Show that the stiffness of the spring = 2.05 R/n. If the above spring is to support a load of 1.2kN with 120mm compression. Calculate mean radius

of the coil and number of turns assuming G = 8200 N/mm^2 and permissible shear stress, $\lambda_{allowable}$ = 250 N/mm^2.

3. A steel shaft ABCD having a total length of 2400mm is contributed by three different sections as follows. The portion AB is hollow having outside and inside diameters 80mm and 50mm respectively, BC is solid and 80mm diameter. CD is also solid and 70mm in diameter. If the angle of twist is same for each section, determine the length of each portion and the total angle of twist. Maximum permissible shear stress is 50 MPa and shear modulus 0.82×10^5 MPa.
4. It is required to design a close coiled helical spring which shall deflect 1mm under and axial load of 100N at a shear stress of 90 MPa. The spring is to be made of round wire having shear modulus of 0.8×10^5 MPa. The mean diameter of the coil is to times that at the coil wire. Find the diameter and length of the wire.
5. A solid circular shaft transmits 75kW power at 200rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed one degree in 2m length of shaft and shear stress is not exceed 50 N/mm^2. Assume the modulus of rigidity of the material of the shaft as 100 kN/mm^2.
6. A shaft has to transmit 110 kW at 160rpm. If the shear stress is not to exceed 65N/mm^2 and the twist in a length of 3.5m must not exceed 1^o, find a suitable diameter. Take C = 8×10^4 N/mm^4.
7. A leaf spring 750mm long is required to carry a central load of 8kN. If the central deflection is not to exceed 20mm and the bending stress is not to be greater than 200N/mm^2. Determine the thickness, width and number of plates. Assume the width of the plates is 12 times, their thickness and modulus of elasticity of the springs material as 200kN/mm^2.

8. A closely coiled helical spring made out of a 10mm diameter steel bar has 12 complete coils, each of mean diameter of 100mm. Calculate the stress induced in the section of rod, the deflection under the pull and the amount of energy stored in the spring during the extension. It is subjected to an axial pull of 200N. Modulus of rigidity is 0.84×10^5 N/mm^2.

9. A close coiled helical spring has a stiffness of 5N/mm. its length when fully compressed with adjacent coils touching each other is 40 cm. the modulus of rigidity of the material of the spring is 0.8x10N/mm^2. Determine the wire diameter and mean coil diameter if their ratio is 1/10. What is the corresponding maximum shear stress in the spring?
10. A circular shaft of 1000mm diameter and 2m length is subjected to a twisting moment which creates a shear stress of 20N/mm^2 at 30mm from the axis of the shaft. Calculate the angle of twist and the strain energy stored in the shaft. Take G=8×10^4 N/mm^2.

UNIT 5- COMPLEX STRESSES AND PLANE TRUSSES,
PART – A (2 Marks)

1. State the advantages of method of sections over the method of joints in the analysis of plane trusses.

2. What is a frame? How are frames classified?

3. Explain determinate and stable frame.

4. What are the equations of equilibrium for a truss as a whole and for a joint?

5. Method of joints is applicable only when the number of unknown forces at the joint under consideration is not more than _________.

6. What is tension co – efficient Method and Method of joints?

7. Write the expression for longitudinal strain and circumferential strain in the case of thin cylindrical shells.

8. What are the assumptions made in analyzing thin spherical shells?

9. A spherical shell of 800 mm is subjected to an internal pressure of 2 N/mm^2. Find the thickness of the shell if the allowable stress in the material of the shell is 100 N/mm^2

10. Define Deficient frame and redundant frame.

11. Define perfect and imperfect frame.

12. Explain the Methods of sections and Method of joints?

13. Write the equation of longitudinal strain in a cylindrical shell, which is subjected to an internal fluid pressure ‘P’.

14. Define circumferential stress and longitudinal stress.

15. How to increase the strength of a thin cylinder?

16. The volumetric strain of a thin spherical shell is ------------- that of the linear strain.

17. In a perfect truss consists of 15 members, the number of joints are-----------------.

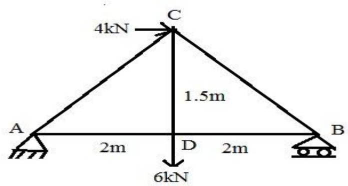
18. State any four methods of analyzing a frame.

19. What is the condition for a plane frame to be perfect?

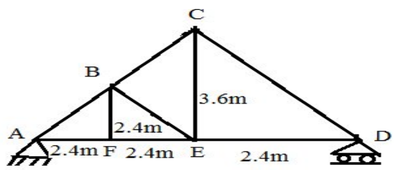
20. Distinguish between thin walled cylinder and thick walled cylinder.

PART-B (16 Marks)

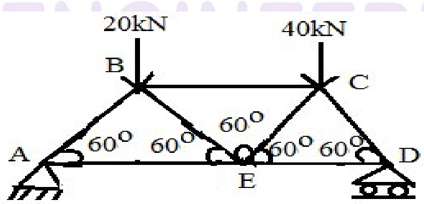
1. Find the forces in the members of the truss shown in Fig.



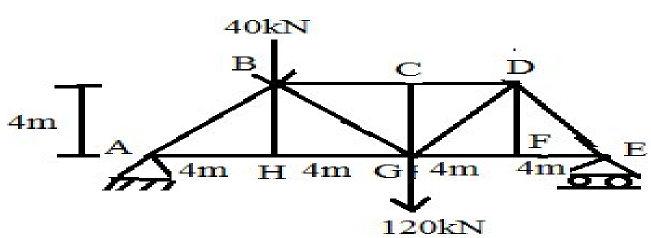
2. Find the forces in the member of the truss shown in fig. by method of sections.



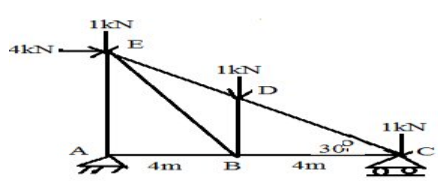
3. Find the forces in all the members of the girder shown in Fig. by the method of joints, indicating whether the force is compressive or tensile.



4. Determine the forces in all members of a truss as shown in fig.



5. For the truss shown in fig find the forces in members CD, CB, BD and AE by method of joints.



6. A thin cylindrical shell 1000 mm long, 200 mm in external diameter, thickness of metal 10 mm is filled with a fluid at atmosphere pressure. If an additional 25 cm^3 of the fluids at atmospheric find the pressure exerted by the fluid on the wall. Take E = 2 x 10^5 N/mm^2 and Poisson's ratio = 0.3. Find also the hoop stress induced.

7. A cylindrical shell 3m long which is closed the ends has an internal diameter of 1m a wall thickness of 15mm. Calculate the Circumferential and longitudinal stresses induced and also changes in the dimensions of the shell, if it is subjected to an internal pressure of 1.5 N/mm^2. Take E = 2 x 10^5 N/mm^2 and 1/m = 0.3.

8. (i) Show that in thin cylinder subjected to internal fluid pressure, the hoop stress is twice the longitudinal stress.

(ii) Derive an expression for the change in volume of a thin cylindrical shell subjected to internal fluid pressure.

9. A cast iron thin cylindrical pipe of internal diameter 200 mm and 15mm thick is closely wounded by single layer steel wire of 2mm diameter under a tension of 50 N/mm^2. Find the stresses set up in the pipe when the pipe is empty. Also find the stresses set up in the pipe and steel wire, when water is admitted in the pipe under a pressure of 5 N/mm^2. Take E for as C.I and steel respectively 1 x 10^5 N/mm^2 and 2x 10^5 N/mm^2. Poisson's ratio = 0.3.

10. A copper cylinder, 90 cm long, 40 cm external diameter and wall thickness 6mm had its both ends closed by rigid blank flames. It is initially full of oil at atmospheric pressure calculate the additional volume of all which must be pumped into it in order to rise the oil pressure to 5 N/mm^2 above atmospheric pressure. For copper assume E = 1.0 x 10^6 N/mm^2 and Poisson's ratio = 1/3. Take bulk modulus of oil is 2.6 x 10^8 N/mm^2.