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Anna University Exams Nov / Dec 2017 - Regulation 2013<br>Rejinpaul.com Unique Important Questions - 3rd Semester BE/BTECH<br>CE6306 STRENGTH OF MATERIALS<br>Important Note: Since SOM is a Problematic Subject, you are advised to Study and Workout similar model problem also

1. A Mild steel rod of $\mathbf{2 0} \mathbf{~ m m}$ diameter and 300 mm long is enclosed centrally inside a hollow copper tube of external diameter 30 mm and internal diameter 25 mm . The ends of the rod and tube are brazed together, and the composite bar is subjected to an axial pull of 40 kN . If E for steel and copper is 200 GN/m2 and $100 \mathrm{GN} / \mathrm{m} 2$ respectively, find the stresses developed in the rod and the tube also find the extension of the rod
2. A cast iron flat 300 mm long and 30 mm (thickness) $\times 60 \mathrm{~mm}$ (width) uniform cross section, is acted upon by the following forces : 30 kN tensile in the direction of the length 360 kN compression in the direction of the width 240 kN tensile in the direction of the thickness. Calculate the direct strain, net strain in each direction and change in volume of the flat. Assume the modulus of elasticity and Poisson's ratio for cast iron as $140 \mathrm{kN} / \mathrm{mm}^{2}$ and 0.25 respectively.
3. The bar shown in fig. is subjected to a tensile load of 160 KN . If the stress in the middle portion is limited to $150 \mathrm{~N} / \mathrm{mm}^{2}$, determine the diameter of the middle portion. Find also the length of the middle portion if the total elongation of the bar is to be 0.2 mm . young's modulus is given as equal to $2.1 \times 10^{5} \mathrm{~N} / \mathrm{mm}^{2}$.

4. A member $A B C D$ is subjected to point loads $P 1, P 2, P 3, P 4$ as shown in fig. calculate the force $P 2$ necessary for equilibrium, if P1 = $45 \mathrm{KN}, \mathrm{P} 3=450 \mathrm{KN}$ and $\mathrm{P} 4=139 \mathrm{KN}$.
Determine the total elongation of the member, assuming the modulus of elasticity to be $2.1 \times 10^{5} \mathrm{~N} / \mathrm{mm}$.

5. A steel rod of 20 mm diameter passes centrally through a copper tube of 50 mm external diameter and 40 mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness. The nuts are tightened lightly home on the projecting parts of the rod. If the temperature of the assembly is raised by $50^{\circ} \mathrm{C}$, calculate the stress developed in copper and steel. Take E for steel and copper as $200 \mathrm{GN} / \mathrm{m}^{2}$ and $100 \mathrm{GN} / \mathrm{m}^{2}$ and $\alpha$ for steel and copper as $12 \times 10^{-6}$ per ${ }^{\circ} \mathrm{C}$ and $18 \times 10^{-6}$ per ${ }^{\circ} \mathrm{C}$.

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6. Drive the relationship between modulus of elasticity and modulus of rigidity. Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter 30 mm and of length 1.5 m if the longitudinal strain in a bar during a tensile stress is four times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of $10 \mathrm{~N} / \mathrm{mm} 2$. Take $\mathrm{E}=1 \times 10^{5} \mathrm{~N} / \mathrm{mm}^{2}$
7. (i). Find the young's modulus of a rod of diameter 30 mm and of length 300 mm which is subjected to a tensile load of 60 KN and the extension of the rod is equal to 0.4 mm .
(ii). The ultimate stress for a hollow steel column which carries an axial load of 2 MN is $500 \mathrm{~N} / \mathrm{mm}^{2}$.If the external diameter of the column is 250 mm , determine the internal diameter Take the factor of safety as 4.0

## Unit II

1. A beam of uniform section 10 m long carries a udl of $2 \mathrm{KN} / \mathrm{m}$ for the entire length and a concentrated load of 10 KN at right end. The beam is freely supported at the left end. Find the position of the second support so that the maximum bending moment in the beam is as minimum as possible. Also compute the maximum bending moment
2. Three blanks of each $50 \times 200 \mathrm{~mm}$ timber are built up to a symmetrical I section for a beam. The maximum shear force over the beam is 4 KN . Propose an alternate rectangular section of the same material so that the maximum shear stress developed is same in both sections. Assume then width of the section to be $2 / 3$ of the depth.
3. A cantilever of 2 m length carries a point load of 20 KN at 0.8 m from the fixed end and another point of 5 KN at the free end. In addition, a u.d.l. of $15 \mathrm{KN} / \mathrm{m}$ is spread over the entire length of the cantilever. Draw the S.F.D, and B.M.D.
4. A Simply supported beam of length 6 metres carries a udl of $20 \mathrm{KN} / \mathrm{m}$ throughout its length and a point of 30 KN at 2 metres from the right support. Draw the shear force and bending moment diagram. Also find the position and magnitude of maximum Bending moment.
5. For the simply supported beam loaded as shown in Fig. , draw the shear force diagram and bending moment diagram. Also, obtain the maximum bending moment.

6. A cantilever 1.5 m long is loaded with a uniformly distribution load of $2 \mathrm{kN} / \mathrm{m}$ run over a length of 1.25 m from the free end it also carries a point load of 3 kn at a distance of 0.25 m from the free end. Draw the shear force and bending moment diagram of the cantilever

Unit III

1. Determine the diameter of a solid shaft which will transmit 300 KN at 250 rpm . The
maximum shear stress should not exceed $\mathbf{3 0 ~ N} / \mathrm{mm} 2$ and twist should not be more than 10 in a shaft length $\mathbf{2 m}$.

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Take modulus of rigidity $=1 \times 10^{5} \mathrm{~N} / \mathrm{mm}^{2}$.
2. A steel shaft ABCD having a total length of 2400 mm is contributed by three different sections as follows. The portion $A B$ is hollow having outside and inside diameters 80 mm and 50 mm respectively, $B C$ is solid and 80 mm diameter. CD is also solid and 70 mm 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 $0.82 \times 10^{5} \mathrm{MPa}$
3. Calculate the power that can be transmitted at a 300 r.p.m. by a hollow steel shaft of 75 mm external diameter and 50 mm internal diameter when the permissible shear stress for the steel is $70 \mathrm{~N} / \mathrm{mm} 2$ and the maximum torque is 1.3 times the mean. Compare the strength of this hollow shaft with that of an solid shaft. The same material, weight and length of both the shafts are the same
4. A solid cylindrical shaft is to transmit 300 kN power at 100 rpm . If the shear stress is not to exceed $\mathbf{6 0}$ $\mathrm{N} / \mathrm{mm}^{\mathbf{2}}$, find its diameter. What percent saving in weight would be obtained if this shaft is replaced by a hollow one whose internal diameter equals to 0.6 of the external diameter, the length, the material and maximum shear stress being the same
5. A helical spring of circular cross-section wire 18 mm in diameter is loaded by a force of 500 N . The mean coil diameter of the spring is 125 mm . The modulus of rigidity is $80 \mathrm{kN} / \mathrm{mm} 2$. Determine the maximum shear stress in the material of the spring. What number of coils must the spring have for its deflection to be $\mathbf{6 ~ \mathbf { m m }}$ ?
6.A close coiled helical spring is to have a stiffness of $1.5 \mathrm{~N} / \mathrm{mm}$ of compression under a maximum load of 60 N . the maximum shearing stress produced in the wire of the spring is $125 \mathrm{~N} / \mathrm{mm}^{2}$. The solid length of the spring is 50 mm . Find the diameter of coil, diameter of wire and number of coils $. C=4.5 \times 104 \mathrm{~N} / \mathrm{mm}^{2}$.
7. A closely coiled helical spring of round steel wire 10 mm in diameter having 10 complete turns with a mean diameter of $\mathbf{1 2} \mathbf{~ c m}$ is subjected to an axial load of $\mathbf{2 5 0}$ N. Determine (a)the deflection of the spring (b)maximum shear stress in the wire and III. stiffness of the spring (c) frequency of vibration. Take C=0.8 $\times 10^{5} \mathrm{~N} / \mathrm{mm}^{2}$

Unit IV

1. For the cantilever beam shown in Fig.3. Find the deflection and slope at the free end. $\mathrm{El}=10000 \mathrm{kN} / \mathrm{m}^{2}$.

2. A beam is simply supported at its ends over a span of 10 m and carries two concentrated loads of 100 kN

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and $\mathbf{6 0} \mathbf{k N}$ at a distance of $\mathbf{2 m}$ and 5 m respectively from the left support. Calculate (i) slope at the left support (ii)slope and deflection under the 100 kN load. Assume $\mathrm{El}=36 \times 104 \mathrm{kN}-\mathrm{m}^{2}$
3. A 3 m long cantilever of uniform rectangular cross-section 150 mm wide and 300 mm deep is loaded with a point load of $3 \mathbf{k N}$ at the free end and a udl of $\mathbf{2 k N} / \mathrm{m}$ over the entire length. Find the maximum deflection. $\mathrm{E}=210 \mathrm{kN} / \mathrm{mm} 2$. Use Macaulay's method.
4. A simply supported beam of span 6 m is subjected to a udl of $2 \mathrm{kN} / \mathrm{m}$ over the entire span and a point load of 3 kN at 4 m from the left support. Find the deflection under the point load in terms of El. Use strain energy method
5. A simply supported beam of uniform flexural rigidity El and span I, carries two symmetrically placed loads $P$ at one-third of the span from each end. Find the slope at the supports and the deflection at mid-span. Use moment area theorems
6. Derive double integration method for cantilever beam concentrated load at free end.

Unit V

1. A thin cylinder 1.5 m internal diameter and 5 m long is subjected to an internal pressure of $2 \mathrm{~N} / \mathrm{mm}^{2}$. If the maximum stress is limited to $160 \mathrm{~N} / \mathrm{mm}^{2}$, find the thickness of the cylinder. $E=200 \mathrm{kN} / \mathrm{mm}^{2}$ and Poisson's ratio $=$ 0.3 . Also find the changes in diameter, length and volume of the cylinder.
2. At a point in a strained material the horizontal tensile stress is $80 \mathrm{~N} / \mathrm{mm}^{2}$ and the vertical compressive stress is $140 \mathrm{~N} / \mathrm{mm}^{2}$. The shear stress is $40 \mathrm{~N} / \mathrm{mm}^{2}$. Find the principal stresses and the principal planes. Find also the maximum shear stress and its planes.
3. A thin cylindrical shell $\mathbf{3} \mathbf{~ m}$ long has 1 m internal diameter and 15 mm metal thickness.

Calculate the circumferential and longitudinal stresses induced and also the change in the dimensions of the shell, if it is subjected to an internal pressure of $1.5 \mathrm{~N} / \mathrm{mm}^{2}$ Take $E=2 \times 10^{5} \mathrm{~N} / \mathrm{mm}^{2}$ and poison's ratio $=0.3$. Also calculate change in volume.
4. A steel cylindrical shell 3 m long which is closed at its ends, had an internal diameter of 1.5 m and a wall thickness of $\mathbf{2 0} \mathrm{mm}$. Calculate the circumferential and longitudinal stress induced and also the change in dimensions of the shell if it is subjected to an internal pressure of $1.0 \mathrm{~N} / \mathrm{mm}^{2}$. Assume the modulus of elasticity and Poisson's ratio for steel as $200 \mathrm{kN} / \mathrm{mm}^{2}$ and 0.3 respectively.
5. A closed cylindrical vessel made of steel plates 5 mm thick with plane ends, carries fluid under pressure of 6 $\mathrm{N} / \mathrm{mm}^{2}$ The diameter of the cylinder is 35 cm and length is 85 cm . Calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter, length and Volume of the cylinder. Take $\mathrm{E}=2.1 \times 10^{5} \mathrm{~N} / \mathrm{mm}^{2}$ and $1 / \mathrm{m}=0.286$
6. Determine the maximum hoop stress across the section of a pipe of external diameter 600 mm and internal diameter 440 mm . when the pipe is subjected to an internal fluid pressure of $50 \mathrm{~N} / \mathrm{mm}^{2}$.

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