KUMARAGURU
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B.E DEGREE EXAMINATIONS: MAY 2017

(Regulation 2015)

Fourth Semester

CIVIL ENGINEERING

U15CET402**:** Strength of Materials

COURSE OUTCOMES After successful completion of this course, the students will be able to

CO1: find the deflection in beams and frames using Energy theorems.

CO2: analyze indeterminate beams.

CO3: analyze the long and short columns and determine the design loads.

CO4: assess the state of stress in three dimensions.

CO5: analyze the structural members using various theories of failures

CO6: solve problems involving unsymmetrical bending in structural members.

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Match List I and List II   CO6 [K_2]

List I	**List II**
A. Curved Beam	i. Centre of twist
B. Unsymmetrical bending	ii. Winkler Bach formula
C. Shear center	iii. Zero stress
D. Neutral Axis	iv. Loading does not lie in a plane

	A	B	C	D
a)	ii	iv	i	iii
b)	i	ii	iii	iv
c)	iv	iii	ii	i
d)	i	iv	ii	iii

2. Theorem of three moments can be used to analyze_____.   CO2   [K_2]

    a) Simply supported beam   b) Continuous beam

    c) Fixed -fixed beam   d) Cantilever beam

3. Consider the following statement followed by the four options: CO1 [K₂]

   The stress induced in a body, when suddenly loaded, is _____ the stress induced when the same load is applied gradually

   1. Once

   2. One-half

   3. Twice

   4. Four times

   Which of the above option is correct

   a) 1,2   b) 4

   c) 3,4   d) 3

4. Choose an indeterminate structure from the following: CO2 [K₂]

   a) Double leaf door   b) Ceiling fan

   c) Suspension bridge   d) Flag post

5. Assertion (A): Maximum shear stress theory has been found to give quite satisfactory results CO5 [K₂] for ductile materials

   Reason (R): The theory does not give as close results as found by experiments on ductile materials. However, it gives safe result

   a) Both A and R are Individually true and   b) Both A and R are Individually true but
       R is the correct explanation of A   R is not the correct explanation of A

   c) A is true but R is false   d) A is false but R is true

6. Which of the following is due to sustained loading CO6 [K₂]

   a) Fatigue   b) Fracture

   c) Bending   d) Creep

7. Consider the following end conditions and arrange them in ascending order of effective CO3 [K₂] length

   1. Both ends pinned

   2. Both ends fixed

   3. Cantilever

   4. One end fixed and another pinned

   a) 1-2-3-4   b) 2-4-3-1

   c) 4-3-2-1   d) 2-3-1-4

8. A vertical column will always tend to bend about   CO3 [K₂]
   a) Maximum moment of inertia   b) Minimum moment of inertia
   c) Maximum lateral dimension   d) Minimum lateral dimension

9. Consider the determination of bending stress in beams of uniform cross section.   CO2 [K₂]

   i. Draw the bending moment diagram

   ii. Determine the maximum bending moment

   iii. Draw the shear force diagram

   iv. Determine I and locate neutral axis

   The correct sequence of steps prior to applying the formula is
   a) i-ii-iii-iv   b) iv-ii-i-iii
   c) iii-i-ii-iv   d) i-iv-iii-ii

10. In the plane of principal stress the shear stress will be   CO4 [K₂]
    a) Zero   b) Infinite
    c) Half of difference between principal   d) Square root of sum of squares of
       stresses   principal stresses

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11.	State Maxwell's Reciprocal Theorem.	CO1	[K₂]
12.	Write the fixed end moments for a fixed beam carrying a point load at mid span.	CO2	[K₂]
13.	Write the Euler's crippling load for the columns with both ends hinged and both ends fixed.	CO3	[K₂]
14.	Define the term volumetric strain.	CO4	[K₂]
15.	Mention different theories of failure.	CO5	[K₂]
16.	What are the reasons for unsymmetrical bending occurring in the beams.	CO6	[K₂]
17.	How will you find the deflection at a point in a beam using Castigliano's Theorem?	CO1	[K₂]
18.	Rewrite the theorem of three moments	CO2	[K₂]
19.	Define middle third rule	CO3	[K₂]
20.	What is meant by shear center?	CO6	[K₂]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. A load of 80 N falls through a height of 20 mm on to a collar rigidly attached to the lower end of a vertical bar of 1.2 m length and 120 mm² cross-sectional area. The upper end of the vertical bar is fixed. Calculate the maximum instantaneous stress induced in the vertical bar, the maximum instantaneous elongation, and the strain energy stored in the vertical rod. Assume $E = 2 \times 10^5$ N/mm²

CO1 [K₄]

22. A fixed beam AB of span 5 m is carrying a uniformly distributed load of 3.5 kN/m over the left half of the span. Find the fixed end moments and the support reactions.

CO2 [K₄]

23. A hollow cylindrical column of 150 mm external diameter and 15 mm thick, 3 m long is hinged at one end and fixed at another end. Find the ratio of Euler and Rankine's critical load. Take $E = 8 \times 10^4$ N/mm², $f_c = 550$ N/mm² and Rankine's constant as 1/1600.

CO3 [K₄]

24. In a triaxial stress system, the six components of the stress at a point are given below: $\sigma_x = 6$ MN/m²; $\sigma_y = 5$ MN/m²; $\sigma_z = 4$ MN/m²; $\tau_{xy} = 1$ MN/m2; $\tau_{yz} = 3$ MN/m2; $\tau_{zx} = 2$ MN/m². Find the magnitude of the three principal stress.

CO4 [K₄]

25. A circular steel shaft is subjected to combined bending and torsion, the bending moment being 20 kNm and torque 10 kNm. If safe equivalent stress in simple tension is 200 N/mm² and Poisson's ratio is 0.25, find suitable diameter of the shaft based on the following theories: (i) Maximum principal stress theory (ii) Maximum shear stress theory (iii) Shear strain energy theory

CO5 [K₄]

26. A beam of Tee section having flange of 100 mm x 20 mm and web of 150 mm x 10 mm and 3m long is simply supported at its ends. It carries 4 kN at 30⁰ to vertical and passing through the centroid of the section. Calculate the maximum tensile stress and maximum compressive stresses. E= 200 kN/mm².

CO6 [K₄]

27. A load of 300 kN is applied on a short concrete column of 250 mm x 250 mm. The column is reinforced by the steel bars of total area 5600 mm². If the modulus of elasticity for the steel is 15 times that of the concrete, find the stresses in concrete and steel. If the stress in concrete should not exceed 4 N/mm², find the area of the steel required so that the column may support a load of 600 kN.

CO1 [K₄]

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