Total No. of printed pages = 14

CE 131602

Roll No. of candidate | | | | | | | | | | |

2017

B. Tech 6th Semester End-Term Examination

STRUCTURAL ANALYSIS – III

Full Marks–100 Pass Marks–35 Time–Three hours

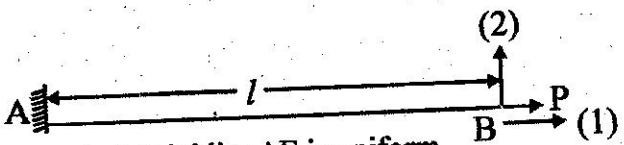
The figures in the margin indicate full marks for the questions.

(Assume any missing data not given in the question.)

1. Answer any *nine* out of the following questions : 2×9=18

(Note : Nine out of following 10 questions are multiple choice questions.)

(i)



Axial rigidity AE is uniform.

Figure-1

[Turn over

As shown in figure–1 above, when a force P is being applied axially along (1) at the free end B of beam AB fixed at A, then the transverse flexibility at the end B along the direction of (2) due to force at (1) would be :

(a) Zero

(b) Function of force P and axial rigidity AE

(c) Function of only axial rigidity AE

(d) Function of axial rigidity AE and length *l*.

(ii) The principle of contragradience that is being used for derivation of joint flexibility matrix from member flexibility matrix of a continuous beam or frame is derived using the concept of :

(a) Principle of virtual work

(b) Principle of minimum strain energy

(c) Castigliano's theorem

(d) None of the above.

(iii) In a given joint stiffness matrix, $K = \begin{bmatrix} K_{ii} & K_{ij} \\ K_{ji} & K_{jj} \end{bmatrix}$, K_{ij} indicates

(a) Force at i due to unit displacement at j

(b) Force at j due to unit displacement at i

(c) Displacement at i due to unit force at j

(d) Displacement at j due to unit force at i

(iv) The flexibility / stiffness matrix of any given order n is a square symmetric matrix because of :

(a) Maxwell's reciprocal theorem

(b) Principle of virtual work

(c) Castigliano's theorem

(d) None of the above

(v) In the plastic analysis, the stress strain curve of mild steel is assumed to be :

(a) Same as that of original stress strain curve of mild steel

(b) Linear

(c) Bi-linear

(d) Parallel to x-axis

(vi) For a given member cross-section in plastic analysis, the shape factor can be expressed as :

(a) $\frac{\text{Plastic Moment}}{\text{Working Moment}}$

(b) $\frac{\text{Ultimate Moment}}{\text{Working Moment}}$

(c) $\frac{\text{Plastic Moment}}{\text{Yield Moment}}$

(d) None of the above.

(vii) Out of the following member cross-sections, which one of the following has the minimum shape factor ?

(a) Triangular section

(b) Circular section

(c) Diamond section

(d) Rectangular section

(viii) For a rectangular section, if the shape factor is 1.5 and permissible bending stress $f = 0.66f_y$, then what will be the load factor ?

(ix) In the plastic analysis, kinematic method or upper bound theorem satisfies :

(a) Equilibrium and mechanism condition

(b) Equilibrium and yield condition

(c) Mechanism and yield condition

(d) None of the above.

(x) Portal method of analysis of frame is _____ (more / less appropriate) as compared to the flexibility / stiffness method of frame analysis subjected to horizontal loads.

2. Answer any *four* out of the following six questions : 4×3=12

(i) In the context of plastic analysis, define the following terms :

(a) Equilibrium condition

(b) Mechanism condition

(c) Yield condition.

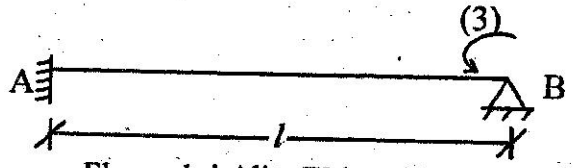
(ii) What is the number of plastic hinges required to form a mechanism in a statically indeterminate structure ? Do we consider the effect of strain hardening in deriving the idealized stress strain curve in plastic analysis ? If no, why ?

(iii) (a) Does the elastic neutral axis and plastic neutral axis perpendicular to the direction of loading coincide in case of symmetrical cross-sections like a rectangular section, explain with proper reasons.

(b) Out of the rectangular and square sections which one of the following has more reserved strength beyond yield value (consider redistribution factor, $K_R = 1$ in both cases).

(iv) Why the diagonal elements of a flexibility/ stiffness matrix are always positive ? Does the flexibility matrix be developed for an unstable structure, if no, why ?

(v) What do you mean by the term "stiffness" used in the stiffness method of analysis ? Derive the expression for flexural stiffness at co-ordinate (3) i.e K_{33} corresponding to the propped cantilever AB shown in figure–2 below :



Flexural rigidity EI is uniform.

Figure-2

(vi) What are the assumptions made in the portal method of analysis of frames subjected to horizontal forces. Do we consider the material and cross-sectional properties of the members while analyzing the frame by portal method ?

3. Answer any *eight* out of the following ten questions : 5×8=40

(i) For the simply supported beam of length *l* shown in figure–3 below, derive the expression for flexibility matrix of order 2 corresponding to co-ordinates (1) i.e transverse and (2) i.e. flexural where flexural rigidity EI is uniform throughout the length of the beam.

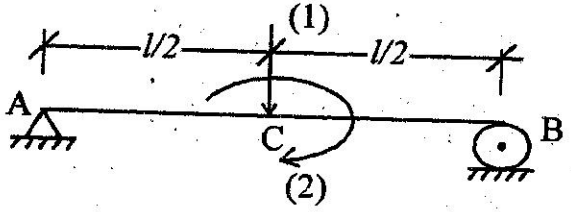


Figure-3

(ii) Develop the stiffness matrix of order 2 for the frame shown in figure–4 below with

respect to co-ordinates (1) and (2). Flexural rigidity is uniform for members AB and BC.

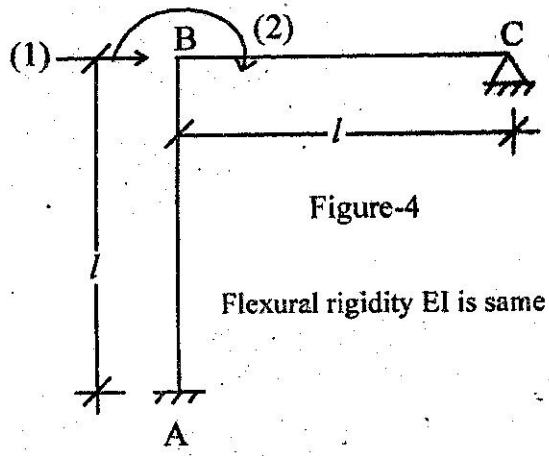


Figure-4

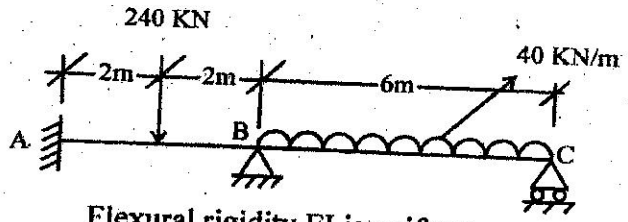
Flexural rigidity EI is same for AB and BC.

(iii) In the context of flexibility matrix method of analysis, state the principle of contragradience. Starting from the principle of virtual work, show that the expression for flexibility matrix i.e $[\partial]$ with respect to system co-ordinates is given by :

$[\partial] = [f]^T[\partial]^*[f]$, where $[\partial]^*$ indicates the flexibility matrix with respect to element co-ordinates.

(iv) Analyse the continuous beam ABC as shown in figure–5 below by using force or flexibility method of analysis and thereby compute

moments M_A and M_B where flexural rigidity EI is uniform throughout the beam.



Flexural rigidity EI is uniform

Figure-5

(v) Derive the expression of shape factor for a diamond section as shown in the figure–6 below :

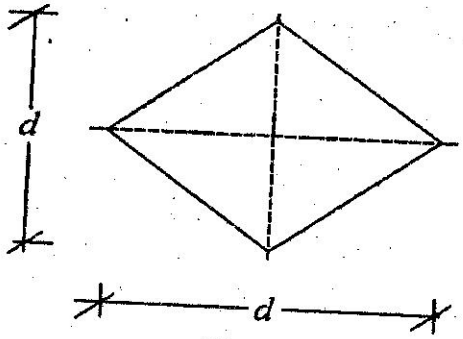


Figure-6

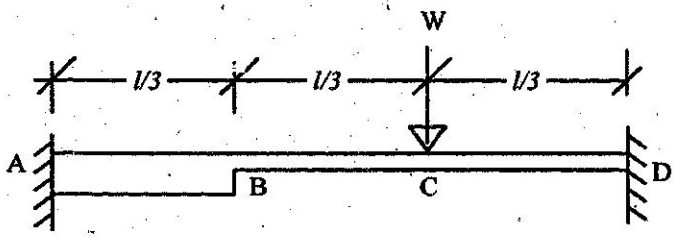
(vi) Draw the idealized stress strain curve of mild steel that is being considered in the plastic analysis of structures. State four assumptions being made in the plastic analysis of structures.

(vii) What do you mean by plastic hinge length ? Derive the expression for plastic hinge length for the following :

(a) A simply supported beam of length "L" of rectangular cross-section subjected to point load "W" at the centre.

(b) A cantilever beam of length "L" of rectangular cross-section subjected to point load " W " at free end.

(viii) Find the collapse load W_U for the continuous beam ABC shown in the figure below :



Plastic moment capacities of AB and BD are 5 M_p and M_p respectively.

Figure-7

(ix) (a) Explain the moment curvature relationship for different types of beam cross-sections in the context of plastic bending of beams.

(b) What is the expression of reserve strength of a structure (Ø) in terms of redistribution factor (K_R) and shape factor and also state the significance of Ø and K_R.

(x) Analyse the portal frame subjected to horizontal loads as shown in the figure–8 below by portal method of frame analysis :

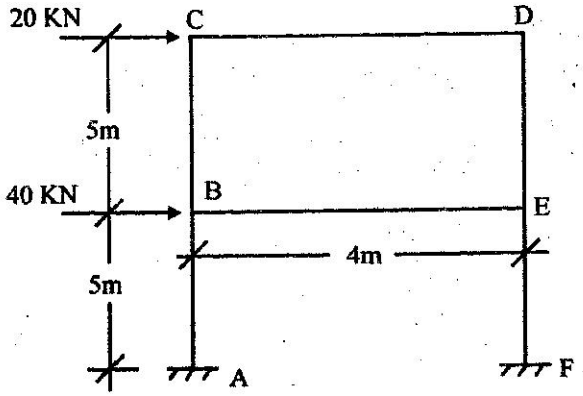


Figure-8

4. Answer any *three* of the following five questions : 3×10=30

(i) Analyse the continuous beam shown in the figure–9 below by using flexibility method of matrix analysis. The downward settlements of supports B and C are 1500/EI and 750/EI

respectively such that $I_{AB} = 2I$, $I_{BC} = 3I$, $I_{CD} = I$, thereby compute redundant moments M_B and M_C.

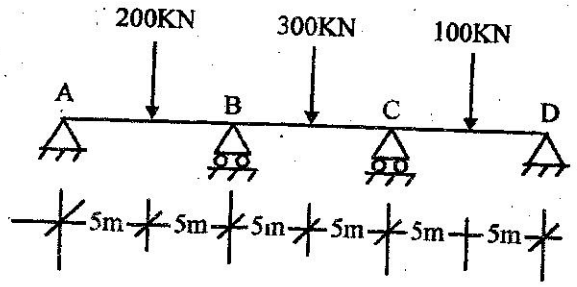
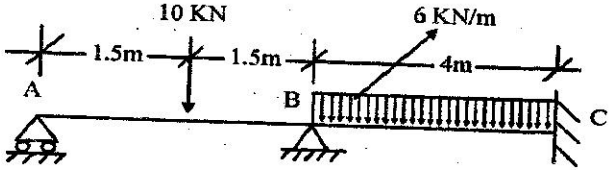


Figure-9

(ii) Analyse the continuous beam shown in the figure-10 below by using stiffness method of matrix analysis and thereby compute moments M_B and M_C. Flexural rigidity EI is same for all members. (rectangular distribution means uniformly distributed load)



Flexural rigidity EI is uniform

Figure-10

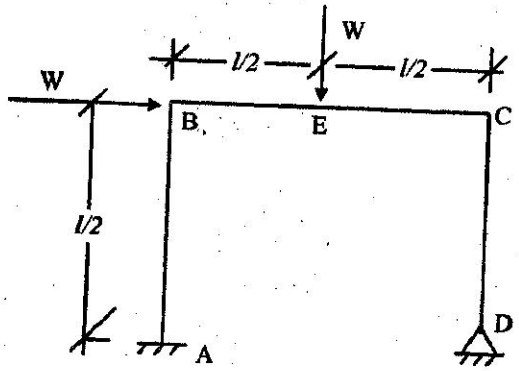
(iii) For a propped cantilever beam subjected to uniformly distributed load 'W' throughout the entire length 'l', find the expression for : 4+6=10

(a) Load at which plastic hinge or yielding will occur

(b) Load at which collapse mechanism will form i.e collapse load

Note : Material and cross-sectional properties are uniform throughout the length.

(iv) (a) Find the collapse load W_U and its associated correct failure mechanism for the portal frame shown in the figure–11 below :



Plastic moment capacities of AB, BC and CD are same equal to M_p. 8

Figure -11

(b) If the portal frame sways to the right, will the plastic hinge be formed at the left corner B in combined mechanism ? Explain with proper reasons. 2

(v) (a) State the assumptions that are being made in the cantilever method of frame analysis. 2

(b) Using portal method of analysis, analyse the portal frame subjected to horizontal loads as shown in the figure–12 below : 8

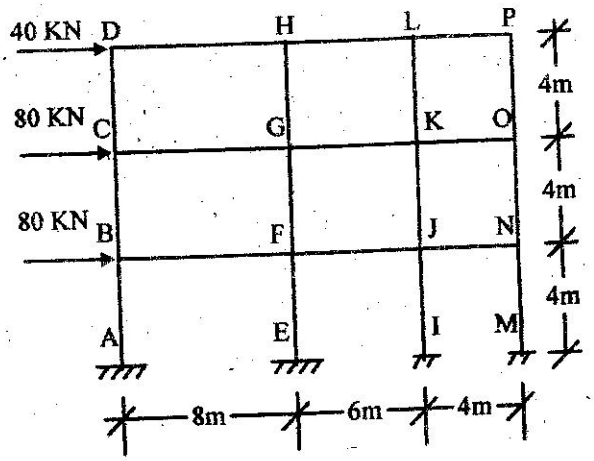


Figure-12