A

Course File

on

STRUCTURAL ANALYSIS-I

(Subject Code: 5CE4-02)

B. TECH III YEAR (V Sem.)

Prepared by

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2020-2021

Sr. No	Name of the Format	Page No.
1	Course details, RTU course no.	
2	Complete Syllabus	
3	Lecture notes, reference books, suggested online / NPTEL certifications related to the course	
4	Quiz/assignments/projects for the course	
5	Course plan showing no. of hours for each lesson/unit	
6	Objectives of Each unit/lesson	
7	Mid-II question papers with COs mapping	
8	CO and PO attainment sheet.	

Course Details

1). Name of Subject: Structural Analysis-I

2). Subject Code: 5CE4-02

2). Instructional Language: - English & Hindi

3). Introduction to subject: -

1 To impart the principles of elastic structural analysis and behaviour of indeterminate structures.

2. To impart knowledge about various methods involved in the analysis of indeterminate structures.

3. To apply these methods for analyzing the indeterminate structures to evaluate the response of structures

4. To enable the student get a feeling of how real-life structures behave

5. To make the student familiar with latest computational techniques and software used for structural analysis.

6. To understand analysis of indeterminate structures and adopt an appropriate structural analysis technique

7. Determine response of structures by classical, iterative and matrix methods

8. Evaluate and draw the influence lines for reactions, shears, and bending moments in beams and girders due to moving load.

7. Apply the methods to calculate slope and deflection as well as force and moments in statically indeterminate structures.

8. Calculate the deflections of truss structures and beams

9. Ability to model and analyze structural systems (bridge and building) with the aid of SAP 2000 and ETABS software .

Lecture notes, reference books, suggested online / NPTEL certifications related to the course.

Prerequisites of the STRUCTURAL ANALYSIS (code: **5CE4-02**) course are:

List of Text and Reference Books

Textbooks

TB1: 'Basic Structural Analysis' by C.S. Reddy, Tata McGraw Hill, New Delhi

TB2: 'Structural Analysis Vol II' by BhaviKatti, Vikash Publishing House Pvt. Ltd.

TB3: 'Theory of Structures' by B.C. Punmia, Laxmi Publication House

TB4: 'Theory of Structures' by S.Ramamrutham, Dhanpat Rai Publishing, New Delhi.

TB5: 'Structural Analysis-A Matrix Approach' by G.S. Pandit, Tata McGraw Hill, New Delhi

TB6: 'Strength of Materials' by Surendra Singh, Katson Publications

TB7: 'Finite Element Method' by S. Senthil, Laxmi Publication House

Reference Books

RB1: 'Theory of Matrix Structural Analysis' by J.S. Przemieniecki, Dover, New York.

RB2: 'Matrix analysis of Framed /structures by W. Weaver and J.M. Gere, Van Nostrand RB3: R. C. Hibbeler, "Structural Analysis" , 8th edition, Pearson Prentice Hall, 2012.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Teaching & Examination Scheme
B.Tech. : Civil Engineering
3rd Year –V Semester

SN	Category	Course Code	Course Title	Contact hrs/week L	T	P	Marks Exm Hrs	IA	ETE	Total	Cr
THEORY											
1	ESC	5CE3-01	Construction Technology & Equipments	2	0	0	2	20	80	**100**	**2**
2	PCC/ PEC	5CE4-02	Structural Analysis-I	2	0	0	2	20	80	**100**	**2**
3		5CE4-03	Design of Concrete Structures	3	0	0	3	30	120	**150**	**3**
4		5CE4-04	Geotechnical Engineering	3	0	0	3	30	120	**150**	**3**
5		5CE4-05	Water Resource Engineering	2	0	0	2	20	80	**100**	**2**
6		Departmental Elective-I:		2	0	0	2	20	80	**100**	**2**
		5CE5-11	Air & Noise Pollution and Control								
		5CE5-12	Disaster Management								
		5CE5-13	Town Planning								
7		Departmental Elective-II:		2	0	0	2	20	80	**100**	**2**
		5CE5-14	Repair and Rehabilitation of Structures								
		5CE5-15	Ground Improvement Techniques								
		5CE5-16	Energy Science & Engineering								
		Sub Total		**16**	**0**	**0**		**160**	**640**	**800**	**16**
PRACTICAL & SESSIONAL											
8	PCC	5CE4-21	Concrete Structures Design	0	0	3	3	45	30	**75**	**1.5**
9		5CE4-22	Geotechnical Engineering Lab	0	0	3	3	45	30	**75**	**1.5**
10		5CE4-23	Water Resource Engineering Design	0	0	2	2	30	20	**50**	**1**
11	PSIT	5CE7-30	Industrial Training	0	0	1		75	50	**125**	**2.5**
12	SODECA	5CE8-00	Social Outreach, Discipline & Extra Curricular Activities	0	0	0		0	25	**25**	**0.5**
		Sub- Total		**0**	**0**	**9**		**195**	**155**	**350**	**7**
		TOTAL OF V SEMESTER		**16**	**0**	**9**		**355**	**795**	**1150**	**23**

***L:** Lecture, **T:** Tutorial, **P:** Practical, **Cr:** Credits*
***ETE:** End Term Exam, **IA:** Internal Assessment*

Office of Dean Academic Affairs
Rajasthan Technical University, Kota

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

3rd Year - V Semester: B.Tech. (Civil Engineering)

5CE4-02: STRUCTURE ANALYSIS-I

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**

2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to Indeterminate structures, Degrees of freedom per node, Static and Kinematic indeterminacy (i.e. for beams, frames & portal with & without sway etc.), Releases in structures, Maxwell's reciprocal theorem and Betti's theorem. Analysis of prop cantilever structures, Analysis of Indeterminate Structure (fixed and continues beams) using Area moment method, Conjugate beam method, Three moments Theorem.	11
3	Analysis of Statically Indeterminate Structures using Slope-deflection method and Moment-distribution method applied to continuous beams and portal frames with and without inclined members	11
4	**Vibrations:** Elementary concepts of structural vibration, Mathematical models, basic elements of vibratory system. Degree of freedom. Equivalent Spring stiffness of springs in parallel and in series. **Simple Harmonic Motion**: vector representation, characteristic, addition of harmonic motions, Angular oscillation. **Undamped free vibration of SDOF system**: Newton's law of motion, D Almbert's principle, deriving equation of motions, solution of differential equation of motion, frequency & period of vibration, amplitude of motion; Introduction to damped and forced vibration.	5
	TOTAL	28

Office of Dean Academic Affairs
Rajasthan Technical University, Kota

Techno India NJR Institute of Technology
Academic Administration of Techno NJR Institute
Syllabus Deployment

Name of Faculty	: Mr. Nishant Sharma	Subject Code: 5CE4-02
Subject	: Structural Analysis - I	
Department	: Civil Engineering	Sem: V
Total No. of Lectures Planned: 28		

COURSE OUTCOMES HERE (3 OUTCOMES)

At the end of this course students will be able to:

CO1. Understand the behaviour of structures under different loading conditions

CO2. Develop the principles and equations for the analysis of statically determinate and indeterminate analysis in preparation for subsequent design courses

CO3. Identify indeterminacy of various structures.

Lecture No.	Unit	Topic
1	1	**INTRODUCTION**: Objective, scope and outcome of the course
2	2	**INTRODUCTION TO INDETERMINATE STRUCTURES**, Degrees of freedom per node
3	2	Static and Kinematic indeterminacy (i.e. for beams & frames)
4	2	Static and Kinematic indeterminacy (i.e. portal with & without sway etc), Releases in structures
5	2	Maxwell's reciprocal theorem
6	2	Bette's theorem
7	2	Analysis of prop cantilever structures
8	2	Analysis of Indeterminate Structure (fixed beams) using Area moment method
9	2	Analysis of Indeterminate Structure (continues beams) using Area moment method

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Dr. Pankaj Kumar Porwal
(Principal)

10	2	Conjugate beam method
11	2	(Contd.) Conjugate beam method
12	2	Three moments Theorem
13	**3**	**ANALYSIS OF STATICALLY INDETERMINATE STRUCTURES** using Slope-deflection method applied to continuous beams
14	3	(Contd.) Slope-deflection method applied to continuous beams
15	3	Slope-deflection method applied to portal frames with inclined members
16	3	(Contd.) Slope-deflection method applied to portal frames with inclined members
17	3	Slope-deflection method applied to portal frames without inclined members
18	3	(Contd.) Slope-deflection method applied to portal frames without inclined members
19	3	Moment-distribution method applied to continuous beams
20	3	(Contd.) Moment-distribution method applied to continuous beams
21	3	Moment-distribution method applied to portal frames with inclined members
22	3	(Contd.) Moment-distribution method applied to portal frames with inclined members
23	3	Moment-distribution method applied to portal frames without inclined members
24	**4**	**VIBRATIONS:** Elementary concepts of structural vibration, Mathematical models, basic elements of vibratory system
25	4	Degree of freedom. Equivalent Spring stiffness of springs in parallel and in series
26	4	Simple Harmonic Motion: vector representation, characteristic, Addition of harmonic motions, Angular oscillation
27	4	Undamped free vibration of SDOF system: Newton's law of motion, D Almbert's principle, deriving equation of motions, solution of differential equation of motion,
28	4	Frequency & period of vibration, amplitude of motion; Introduction to damped and forced vibration

TEXT/REFERENCE BOOKS

1. Strength of Materials & Mechanics of Structures: Vol. I by Dr. B.C. Punmia Laxmi Publications (p) Ltd.
2. Theory of Structure by Jangid & Negi, Tata Mc Graw Hill.
3. Structural Analysis by Hibbler R.C., Pearsons.

Techno India NJR Institute of Technology

Bhamashah (RIICO) Industrial Area, Kaladwas, Udaipur

B.Tech. V–Semester Mid Term Examination III (2019)
5CE4-02: Structural Analysis – I

Time:2 Hours **Maximum Marks: 80**

Roll No.:

Part A (*Attempt all questions. Each question carries 2 marks*)

Q1. Describe the difference between damped and un-damped vibrations?

Q2. Describe the concept of releases in structure.

Q3. What is member stiffness factor in moment distribution method?

Q4. What is natural frequency of vibration?

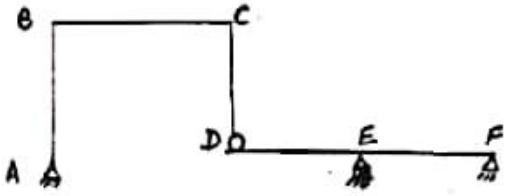
Q5. Describe logarithmic decrement.

Part B (*Attempt any **Four** questions. Each question carries 10 marks*)

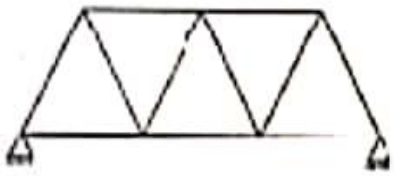
Q6. Describe the problems caused by vibration and how these problems can be minimized. Also describe D'Almbert's Principle and its applications.

Q7. Define degree of static and kinematic indeterminacy. Determined degree of kinematic and static indeterminacy of following structures.

(a)

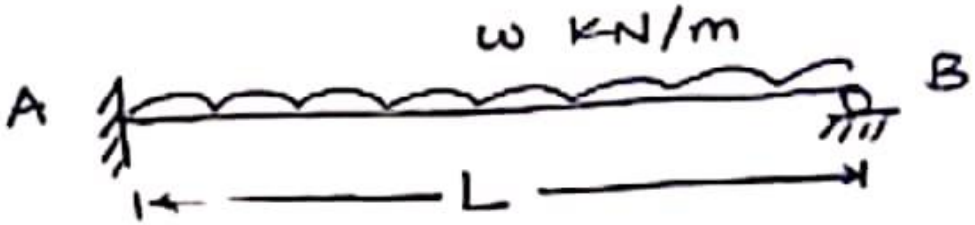


(b)

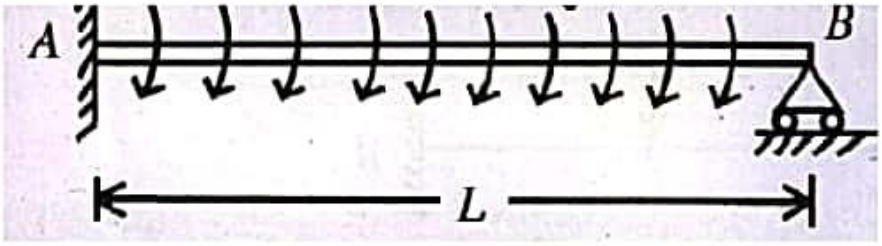


P.T.O.

Q8. Find support reaction at B using conjugate beam method.



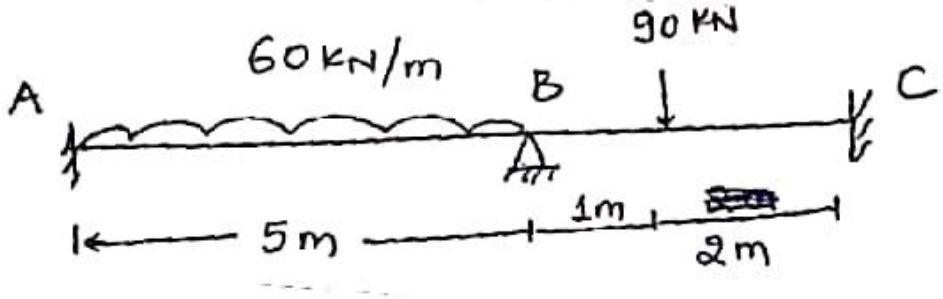
Q9. Find support reaction at B using moment area method.



Q10. A mass of 1 kg is suspended by a spring having stiffness of 600 N/m. The mass is displaced downwards from its equilibrium position by a distance of 0.01 m. Find (a) equation of motion of the system (b) natural frequency of the system (c) response of the system as a function of time (d) total energy of the system.

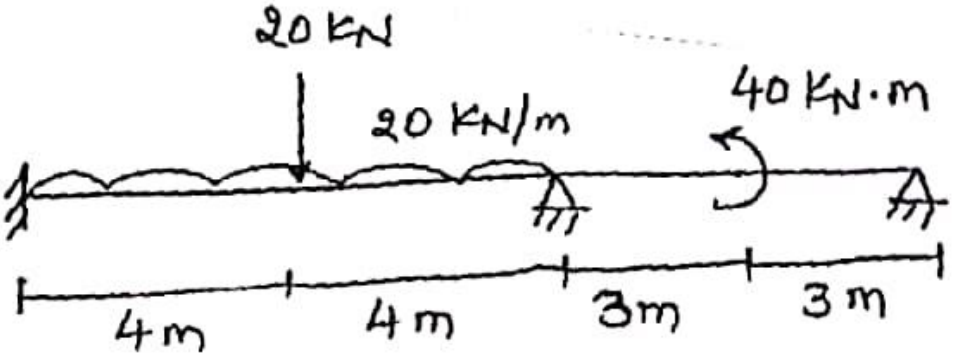
Part C (*Attempt any Two questions. Each question carries 15 marks*)

Q11. Draw SFD and BMD using slope deflection equation.

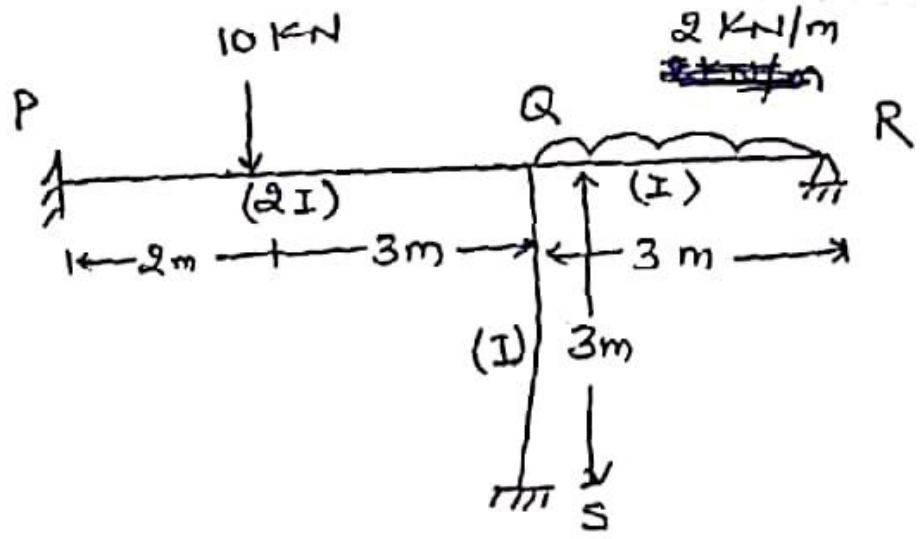


P.T.O.

Q12. Draw SFD and BMD using theorem of three moments.



Q13. (a) Find end moments using moment distribution method **(8 Marks)**



P.T.O.

Assignment No. 1

1 Give advantages & disadvantages of statically indeterminate structures
2 Differentiate statically determinate and indeterminate structures
3 Differentiate Plane frame and Grid
4 Give advantages of fixed beam over a simply supported beam
5 Define Static & Kinematics indeterminacy
6 Give equations of Static and Kinematics Indeterminacy for the following structures with meaning of each term used
(i) Beam
(ii) Plane truss
(iii) Plane Frame
(iv) Grid
7 State and explain principle of superposition.
8 Explain Maxwell's theorem of reciprocal deflections
9 Determine Structural indeterminacy of the structures shown in figure

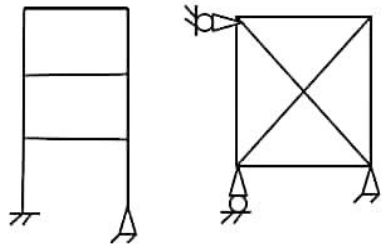


Figure 1

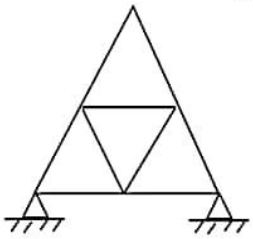


Figure 2

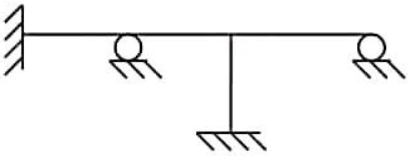


Figure 3

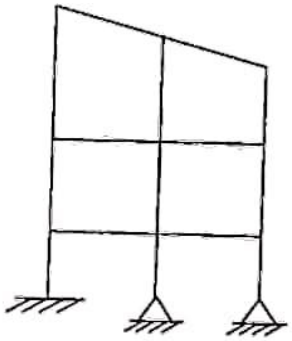


Figure 4A

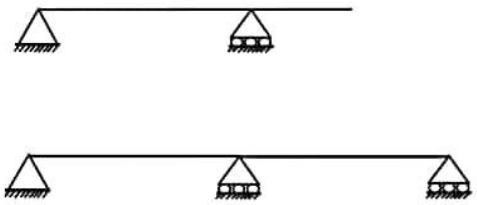


Figure 4B

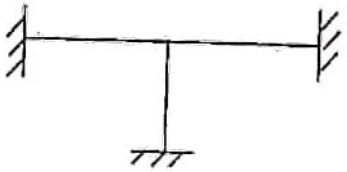


Figure 4C

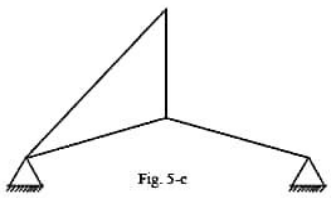


Fig. 5-c

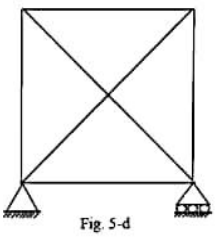


Fig. 5-d

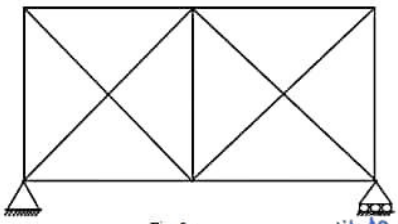


Fig. 5-e

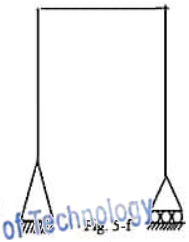


Fig. 5-f

Assignment No. 2

1 Derive relation among slope, deflection and radius of curvature

2 Derive an equation to determine deflection at center for the simply supported beam subjected to uniformly distributed load over an entire span.

3 Which points should be take care while using Macaulay's Method

4 Using Macaulay's method calculates slope at point C and deflection at point D for a simply supported beam as shown in **fig.-1**. Take EI=Constant

5 Determine deflection at B, C and D for the cantilever beam loaded as shown in **fig.-2** using Macaulay's method. Take E=2 x 10^5 N/mm2 & I = 2 x 10^8 mm4

6 Explain theorems of moment area method

7 Enlist advantages of double integration method and moment area method

8 Find slope & deflection for the structure shown in **fig.-3** below by Moment area method

9 Define Conjugate beam Theorems

10 Write difference between conjugate beam and real beam

11 Find deflection at C and slope at A for a simply supported beam as shown in **fig.-4** by conjugate beam method.

12 Find slope and deflection at point C for the beam shown in **fig.-5** using Conjugate beam method. Take EI = 20000 KN-m2

13 A simply supported beam is subjected to a central point load. If the slope is 0.8^0 at support due to the effect of loading, calculate deflection at center. Length of the beam is 3m

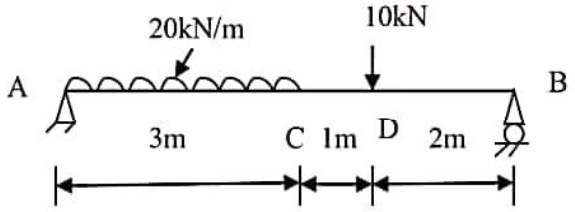


Figure 1

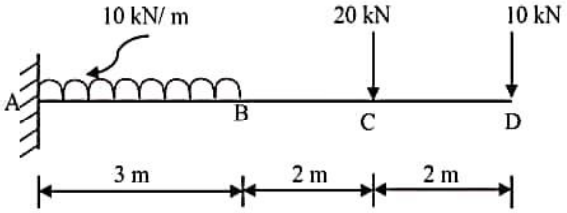


Figure 2

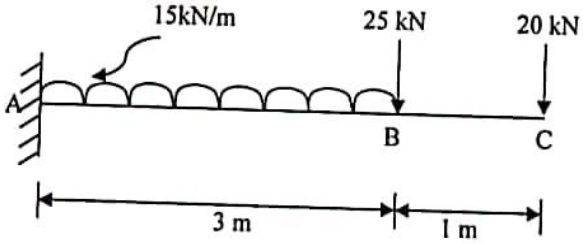


Figure 3

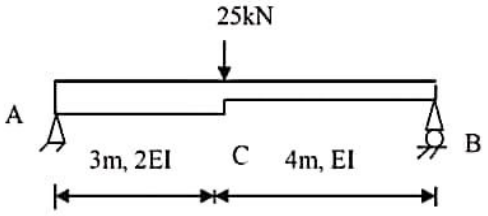


Figure 4

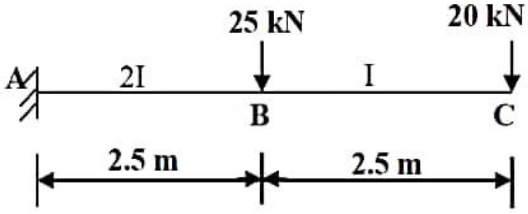


Figure 5

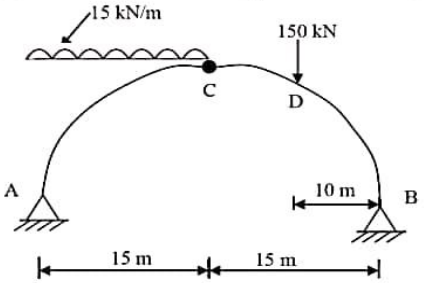
Assignment No. 3

1 Show that for a three hinged parabolic arch carrying a uniformly distributed load over the whole span, the Bending moment at any section is zero and also calculate horizontal thrust at support

2 Write advantages of Three Hinge parabolic arch over a Simply supported beam

3 The cables of a suspension bridge of 100m span are suspended from piers which are 12m and 6m respectively above the lowest point of the cable. The load carried by each cable is 1 KN/m of span. Find
(i) horizontal pull in the cable at the pier
(ii) Maximum Tension in the cable at the pier.

4 Calculate reaction at supports and draw bending moment diagram for the three-hinge arch as shown in fig.



5 A suspension cable having supports at the same level has a span of 40m and a maximum dip of 3m. The cable is loaded with a uniformly distributed load of 10 kN/m through out its length. Find the maximum tension in the cable

6 A symmetrical three hinged circular arch has a span 20 m and central rise 5 m. It carries a point load of 20 kN at 5 m from left support. Calculate value of thrust at springing. Also calculate maximum positive Bending Moment and Bending Moment at 6.0 m from left support

7 A cable of horizontal span of 28 m is to be used to support six equal loads of 50 kN each at 4 m spacing. The central dip of the cable is limited to 2.0 m. Find the length of the cable required and its sectional area if the safe tensile stress is 750 N/mm2

8 A symmetrical three hinged circular arch has a span of 16 m and a rise to the central hinge of 4 m. It carries a vertical load of 20 kN at 5 m from the left hand end. Find
(a) the magnitude of the thrust at the springing,
(b) the Reactions at the supports,
(c) Bending moment at 8 m from the left hand hinge

Question Bank

Code : 011511

B.Tech 5th Semester Examination, 2016

Structural Analysis-I

Time : 3 hours *Full Marks : 70*

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are Nine questions in this paper.

(iii) Attempt five questions in all.

*(iii) **Question No. 1 is Compulsory.***

---

1. Choose the correct option (any seven): 7×2=14

(a) The principle of superposition is applicable for:

(i) A linear beam / frame structure

(ii) A linear truss structure

(iii) Any linear structure

(iv) The material of the structure is linearly elastic

(b) The loading for a conjugate beam is given by the

(i) Loading of the original beam

(ii) Shear force diagram of the original beam

(iii) Bending moment diagram of the original beam

(iv) Curvature diagram of the original beam

(i) $\frac{1}{2}\frac{EI}{L}$

(ii) $\frac{EI}{L}$

(iii) $\frac{2EI}{L}$

(iv) $\frac{6EI}{L}$

(g) A closed rectangular frame with an internal hinge, is statically:

(i) Determinate

(ii) Indeterminate of order one

(iii) Indeterminate or order two

(iv) Indeterminate of order three

(h) If the length of a simply supported beam is doubled, the flexural rigidity of the beam will be :

(i) Halved

(ii) Doubled

(iii) Increased by four times

(iv) Remain same

(i) The ordinates of influence line diagram for bending moment always have the dimensions of

(i) Force

Code : 011511

B.Tech 5th Semester Exam., 2015

STRUCTURAL ANALYSIS—I

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

(iv) Question No. 1 is compulsory.

1. Choose the correct option (any *seven*) : 2×7=14

(a) Maximum bending moment in a beam occurs, where

(i) deflection is zero

(ii) share force is maximum

(iii) shear force is minimum

(iv) shear force changes sign

(b) The diagram showing the variation of axial load along the span is called

(i) shear force diagram

(ii) bending moment diagram

(iii) thrust diagram

(iv) influence line diagram

(i) Muller Breslau's principle for obtaining influence lines is applicable to

1. trusses
2. statically determinate beams and frames
3. statically indeterminate structures, the material of which is elastic and follows Hooke's law
4. any statically indeterminate structure

The correct answer is

(i) 1, 2 and 3

(ii) 1, 2, and 4

(iii) 1 and 2

(iv) only 1

2. *(a)* Evaluate the forces in all the members of the truss shown in Fig. 1 by method of tension coefficient. 7

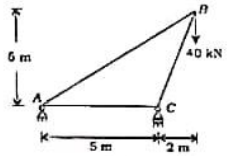


Fig. 1

(b) Determine the forces in the members of the truss shown in Fig. 2 7

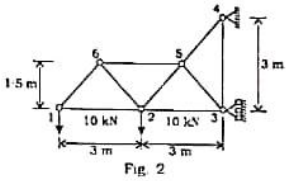


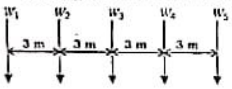
Fig. 2

3. A simply supported beam has a span of 12 m uniformly distributed load of 40 kN/m and 5 m long crosses the girder from left to right. Draw the influence line diagram for SF and BM at a section 4 m from left end. Use the diagram to calculate maximum SF and BM at this section 14

4. *(a)* A three-hinged circular arch hinged at the springing and crown points has a span of 40 m and a central rise of 8 m. It carries a uniformly distributed load 10 kN/m over the left half of the span together with a concentrated load of 80 kN at the right quarter span point. Find normal thrust and shear at a section 10 m from the left support. 7

(b) A symmetrical three-hinged parabolic arch of span L and central rise of h carries a single-point load of W kN that may be placed anywhere on the span. Locate the position of load on the arch in order to get the maximum bending moment in the arch. 7

5. The load system shown in Fig. 3 crosses a beam simply supported over a span of 24 m. Using influence line, calculate maximum Bending Moment under 25000 N load 14



W_1 = 10000 N
W_2 = 20000 N
W_3 = 20000 N
W_4 = 25000 N
W_5 = 15000 N

Fig. 3

6. Using conjugate method, determine the rotations at A, B and deflection at C point for a beam shown in Fig. 4. 14

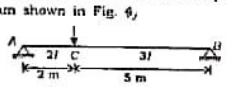


Fig. 4

7. (a) Explain with suitable sketch, the principle of virtual work and Casuglione's theorem. 6

(b) State and explain Maxwell-Betty's theorem with figure 8

8. Determine the vertical deflection of joint E of a truss shown in Fig. 5. Take A = 2000 mm^2 and E = 200 kN/mm^2. 14

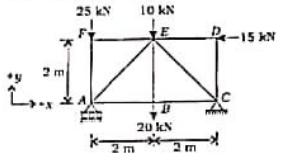


Fig. 5

9. (a) Discuss about flexibility and stiffness method. Give suitable examples 7

(b) Find the stiffness matrix for the cantilever shown in Fig. 6. 7

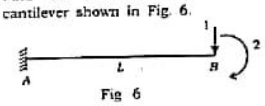


Fig. 6

★★★

(f) Castigliano's theorem for deflection, i.e., $\frac{\partial U}{\partial P} = \delta$ (deflection) is true for

(i) linearly elastic material
(ii) rigid material
(iii) non-linearly elastic material
(iv) any material, elastic or inelastic

(g) The maximum bending moment due to train of wheel loads on a simply-supported girder

(i) always occurs at the centre of span
(ii) always occurs under the wheel load
(iii) Both (i) and (ii)
(iv) occurs at the $\frac{1}{4}$th of any support

(h) Three-moment equation is applicable, when

(i) the beam is prismatic
(ii) there is no settlement of support
(iii) there is no discontinuity within the span
(iv) the spans are equal

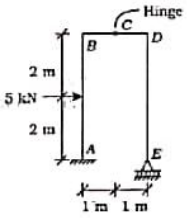
(i) The theorem of three moments expresses the condition of

(i) equilibrium of forces
(ii) slope compatibility
(iii) Maxwell's reciprocal theorem

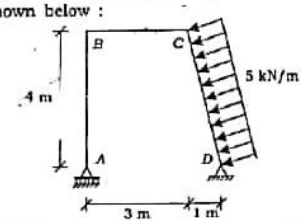
(j) The rotational stiffness of a cantilever beam at its free end is

(i) EI/L
(ii) $2EI/L$
(iii) $3EI/L$
(iv) $4EI/L$

2. Calculate the reactions at the supports for the frame shown below :



3. Draw the SF and BM diagrams for the frame shown below :



Code : 011511

B.Tech. 5th Semester Exam., 2014

STRUCTURAL ANALYSIS—I

Time : 3 hours *Full Marks* : 70

Instructions:

(i) All questions carry equal marks.

(ii) There are NINE questions in this paper.

(iii) Attempt FIVE questions in all.

(iv) Question No. 1 is compulsory.

1. Choose the correct one (any seven) :

(a) In a pin-jointed truss, the members may be subjected to bending, if

(i) the material of the truss does not obey Hooke's law

(ii) the truss is statically indeterminate

(iii) the loads are not applied at the nodes

(iv) there is support settlement

(b) Point of contraflexure occurs in a structure, when

(i) bending moment is zero

(ii) bending moment changes sign

(iii) shear force is zero

(iv) All of the above

  (Turn Over)

(c) In a vertically loaded propped cantilever, any settlement of the prop would

(i) reduce the hogging BM at the fixed end

(ii) increase the hogging BM at the fixed end

(iii) affect only SF and not BM values

(iv) affect neither BM nor SF values

(d) A simply-supported beam of 8 m span is loaded by a u.d.l. and has maximum deflection of 16 mm. If the span is halved (i.e., 4 m) and the loading is doubled, the maximum deflection will be

(i) 2 mm

(ii) 4 mm

(iii) 8 mm

(iv) 16 mm

The fixed support in a read beam becomes —— in the conjugate beam.

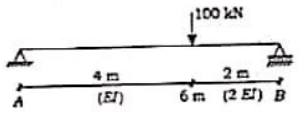
(i) roller support

(ii) hinged support

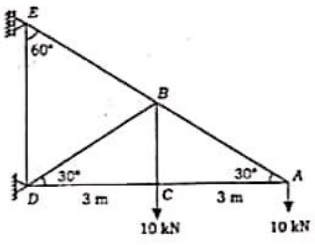
(iii) free support

 (Continued)

4. Calculate the maximum deflection in the beam and its location :

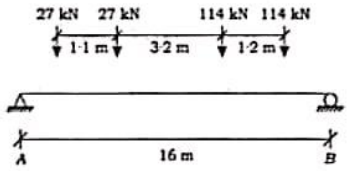


5. Determine the deflection of the point A of the truss $E = 2 \times 10^5$ N / mm^2 and A = cross section = 100 mm^2 (all the members) :

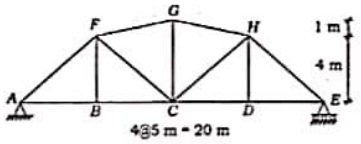


  (Turn Over)

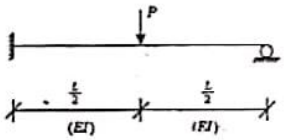
6. Determine the absolute maximum shear and moment for the beam as shown below, when a standard IRC class-A driving vehicle traverse in either direction :



7. Draw the IL for the forces in members *CD*, *CH* and *GH* :



8. Using the method of consistent displacements, determine the reactions of the beam as shown below :



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