Course File

Course file is systematic documentation, which includes following items.

1. content
2. Vision of department
3. Mission of department
4. PEO’s
5. PO’s
6. Course objectives and course outcomes(Co)
7. Mapping of CO’s with PO’s
8. Course syllabus and GATE syllabus
9. Time table
10. Student list
11. Course handouts
12. Lecture plans
13. Assignment
14. Power point presentation (Course materials)
15. Lecture notes (course materials)
16. Reference materials (Course materials)
17. Tutorial sheets
18. Sessional question paper
19. University question paper
20. Question bank
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22. Result
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24. Quality measurement sheets a. course end survey b. teaching evaluation

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

COURSE FILE
OF
STRUCTURAL ANALYSIS-I
(011X11)

Faculty Name:
Prof. RISHI SRIVASTAVA
ASSISTANT PROFESSOR

Prof. SUSHILA SHARMA
ASSISTANT PROFESSOR

DEPARTMENT OF CIVIL ENGINEERING

विज्ञान एवं प्रावैधिकी विभाग
Department of Science and Technology
Government of Bihar

Content

VISION OF DEPARTMENT

To get recognized as prestigious civil engineering program at national and international level through continuous education, research and innovation.

MISSION OF DEPARTMENT

- To create the environment for innovative and smart ideas for generation of professionals to serve the nation and world with latest technologies in Civil Engineering.
- To develop intellectual professionals with skill for work in industry, acedamia and public sector organizations and entrepreneur with their technical capabilities to succeed in their fields.
- To build up competitiveness, leadership, moral, ethical and managerial skill.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates are expected to attain Program Educational Objectives within three to four years after the graduation. Following PEOs of Department of Civil Engineering have been laid down based on the needs of the programs constituencies:

PEO1: Contribute to the development of civil engineering projects being undertaken by Govt. and private or any other sector companies.

PEO2: Pursue higher education and contribute to teaching, research and development of civil engineering and related field.

PEO3: Successful career as an entrepreneur in civil engineering industry

PROGRAMME OUTCOMES (PO)

PO1	**Engineering knowledge**: An ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to get the solution of the engineering problems.
PO2	**Problem analysis:** Ability to Identify, formulates, review research literature, and analyze complex engineering problems.
PO3	**Design/development of solutions:** Ability to design solutions for complex engineering problems by considering social, economical and environmental aspects.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge to design, conduct analyse experiments to get valid conclusion.
PO5	**Modern tool usage:** ability to create, select, and apply appropriate techniques, and to model complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Ability to apply knowledge by considering social health, safety, legal and cultural issues.
PO7	**Environment and sustainability:** Understanding of the impact of the adopted engineering solutions in social and environmental contexts.
pPO8	**Ethics**: Understanding of the ethical issues of the civil engineering and applying ethical principles in engineering practices.
PO9	**Individual and teamwork:** Ability to work effectively as an individual or in team, as a member or as a leader.
PO10	**Communication:** An ability to communicate clearly and effectively through different

	modes of communication.
PO11	**Project management and finance:** Ability to handle project and to manage finance related issue
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning.

COURSE OBJECTIVE AND COURSE OUTCOMES:

Institute/college Name	MuzaffarpurInsittute of Technology, Muzaffarpur
Program Name	B.E. Civil (V semester)
Course Code/course credits	011X11 (3)
Course Name	Structural Analysis-I
Lecture/ Sessional (per week)	3/3
SEE duration	3 hours

1. Scope and Objectives of the Course

This course is designed to review the fundamentals and practices of structural engineering within the Civil Engineering curriculum. Students will explore the concept of global structural stability, theory of structural analysis, and methods in structural analysis.

Students who successfully complete this course will be able to:

1. Distinguish between stable and unstable structures; statically determinate and indeterminate structures.
2. Apply equations of equilibrium to structures and compute the reactions
3. Derive the shear and bending moment equations for indeterminate structures and draw the shearing force and bending moment diagrams.
4. Calculate the internal forces in cable and arch type structures
5. Evaluate and draw the influence lines for reactions, shears, and bending moments in beams and girders due to moving load.
6. Apply the methods to calculate slope and deflection as well as force and moments in statically indeterminate structures.
7. Calculate the deflections of truss structures and beams
8. Ability to model and analyze structural systems (bridge and building) with the aid of SAP 2000 and ETABS software .

2. **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

3. **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.

MAPPING OF COs AND POs

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Correlation level: 1- slight (Low) 2- moderate (Medium) 3-substantial (High)

COURSE SYLLABUS:

STRUCTURAL ANALYSIS - I

1. **Basic introductory concepts :** structural systems, elements, joints, stability, equilibrium, compatibility, indeterminacy, types of loading.
2. **Force-displacement relation,** free-body diagrams; analysis of forces in statically determinate structures : trusses (including compound and complex trusses), beams and frames (including internal hinges), cables and three hinged.
3. **Stability of Walled Structures**
4. **Influence lines** for beams and trusses under moving loads; Criteria for maxima.
5. **Work and energy principles :** principle of virtual work, potential energy and Clastingliano's theorems,
6. complementary energy theorems, reciprocal theorems and Mueller Breslau's principle with applications.
7. **Analysis of displacements** in statically determinate structures : Unit (dummy) load and energy methods, moment area and conjugate beam methods, Williot-Mohr diagram.
8. **Introduction to Matrix Methods** for determinate structures : Flexibility & Stiffness Methods.

GATE Syllabus of Structural Analysis:

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR

Lecture No.	**I**	**II**	**III**	**IV**		**V**	**VI**	**VII**
Day	**09:00-10:00AM**	**10:00-11:00AM**	**11:00-12:00AM**	**12:00-01:00PM**	**01:00-02:00PM**	**02:00-03:00PM**	**03:00-04:00PM**	**04:00-05:00PM**
Mon					R			
Tues					E			
Wed					C	Structure Tutorials	Structure Tutorials	
Thurs	Structure				E			
Fri			Structure		S			
Sat		Structure	Structure Tutorials	Structure Tutorials	S			

STUDENT LIST:

Sl. No.	ROLL NUMBER	NAME
1	16C01	MANI SHANKAR
2	16C02	NAVNEET KUMAR NAYAN
3	16C03	SWATI
4	16C04	PULKIT PAWAN
5	16C05	GHYANENDAR KUMAR
6	16C06	SAURABH KUMAR
7	16C07	SUMIT KUMAR GUPTA
8	16C08	JAY PRAKASH KUMAR
9	16C09	AYUSH ANANT
10	16C10	AKASH KUMAR
11	16C11	PAWAN KUMAR
12	16C12	SHAMBHU KUMAR
13	16C13	RICHA SINHA
14	16C14	RAJEEV RANJAN
15	16C15	RAHUL RANJAN
16	16C18	RIYA KUMARI
17	16C19	BIPIN BIHARI
18	16C21	BIPIN KUMAR PATEL
19	16C22	KAVIRANJAN KUMAR
20	16C23	SONU KUMAR
21	16C24	RUDRA PRATAP
22	16C25	SHIVAM KUMAR SINGH
23	16C26	RAUSHAN KUMAR
24	16C27	VIVEK KUMAR
25	16C28	MD QAMRE ALAM
26	16C30	SONU RAJ
27	16C31	RAJ KUMAR PRASAD
28	16C32	JYOTI KUMARI
29	16C33	CHANDAN KUMAR
30	16C34	DEEPAK KUMAR
31	16C35	SONU KUMAR
32	16C36	VIBHISHAN KUMAR
33	16C37	AKHILESH KUMAR
34	16C38	SUMIT KUMAR
35	16C39	RAUSHAN KUMAR
36	16C42	DILIP KUMAR
37	16C43	MANISH KUMAR

38	16C44	RAHUL KUMAR MISHRA
39	16C45	JAGAT NARAYAN
40	16C46	YASHBINDRA KUMAR
41	16C47	GOLDEN KUMAR
42	16C48	ANKIT KUMAR
43	16C49	AVINASH KUMAR
44	16C50	ROHIT KUMAR
45	16C51	HITESH KUMAR SAH
46	16C52	ROSHAN KUMAR
47	16C53	MANISH KUMAR
48	16C55	PANKAJ KUMAR
49	16C56	RAUSHAN KUMAR
50	16C57	RAKESH KUMAR
51	16C58	ASHISH KUMAR
52	16C59	SANJEEV KUMAR
53	16C60	SONU KUMAR
54	16C61	ABHIJEET RAJ
55	16C62	RISABH KUMAR
56	16C63	SHASHI SHEKHAR KUMAR
57	16C64	SANDEEP KUMAR GUDDU
58	16C65	SIKHA PURNIMA
59	15C09	RAMESH KUMAR
60	15C36	SAURABH KUMAR SINGH
61	17(LE)C01	RATNESH PASWAN
62	17(LE)C02	SHASHI KUMAR
63	17(LE)C03	PANKAJ KUMAR
64	17(LE)C04	SAROJ KUMAR
65	17(LE)C05	RUPESH KUMAR
66	17(LE)C06	PRABHAT RANJAN
67	17(LE)C07	KISHANKANT KUMAR
68	17(LE)C08	HASAN RAZA
69	17(LE)C09	MD. ATHRIUAN ANSARI
70	17(LE)C10	MD. HASNAIN

Text Books:

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

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COURSE PLAN

Lecture Number	Topics	Text Book / Reference Book / Other reading material
1-3	**Introduction**	TB1, TB5
	Static Indeterminacy, Kinematic Indeterminacy, Internal forces, Equilibrium equations, Free Body Diagram, Shear Force and Bending Moment Diagram, Compatibility Equations.	
4- 12	**Analysis of statically indeterminate structures**	TB6, RB3
	Moment Area Theorem and related problems, Conjugate Beam Method and related problems, Three Moment theorem and related problems, Basic idea of Influence Lines, Influence Lines for Propped Cantilever Beam, Continuous Beam and Two-Hinged Arch Beam	
13-24	**Introduction of Force and Displacement Method and Energy Method**	TB2, TB4, RB3
	Consistent Deformation Method and related problems, Slope Deflection Method	

	and related problems, Moment Distribution Method and related problems	
25-34	**Matrix formulation of force and displacement methods**	TB5, RB2
	Solution of simultaneous equations; Stiffness matrix approach with reference to computer application; generation of frame element stiffness matrix; Concept of local effects; Application to plane frames, space frames, grid structures.	
35-41	**Finite element Method**	TB7
	Introduction to Finite Element Method, FEM application to 2D problems, FEM application to plane problem	
42-46	**Introduction to Structural Analysis Software**	Bentley Software Manual
	STAAD PRO Software, e-tab Software	

<u>Assignment No. 1</u>

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

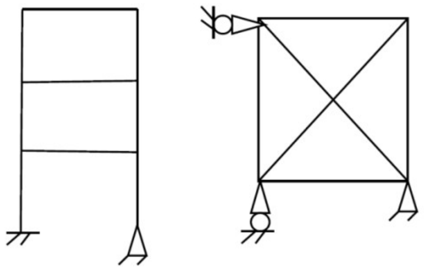


Figure 1

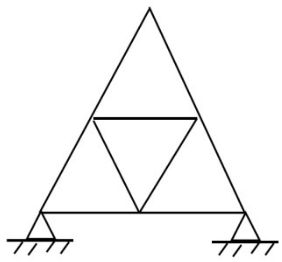


Figure 2

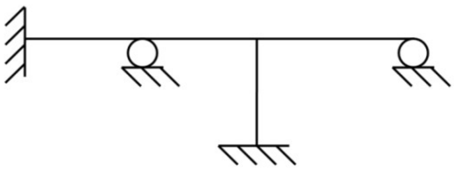


Figure 3

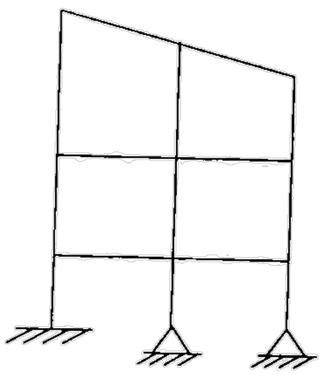


Figure 4A

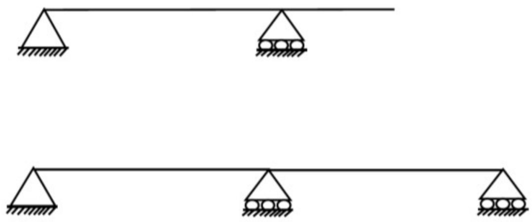


Figure 4B

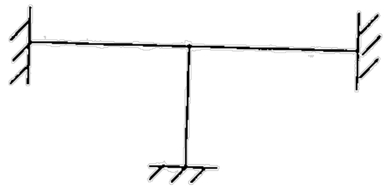


Figure 4C

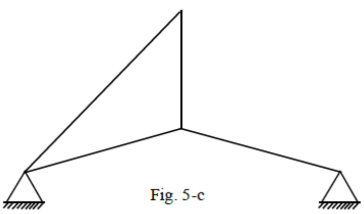


Fig. 5-c

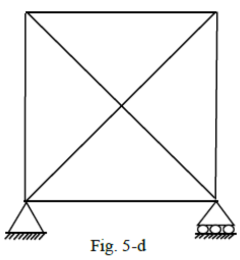


Fig. 5-d

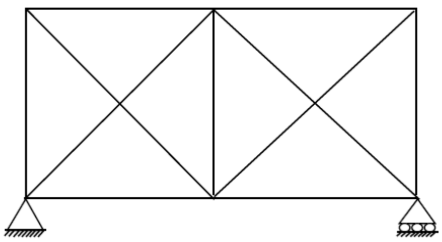


Fig. 5-e

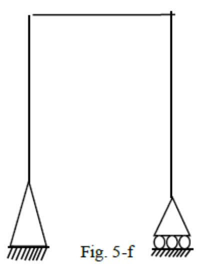


Fig. 5-f

<u>**Assignment No. 2**</u>

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

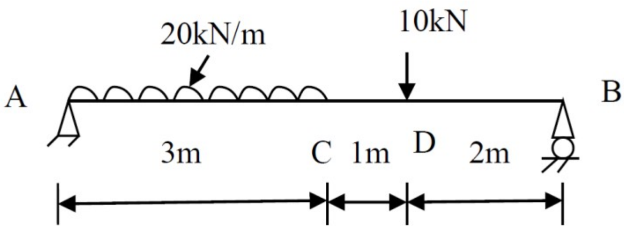


Figure 1

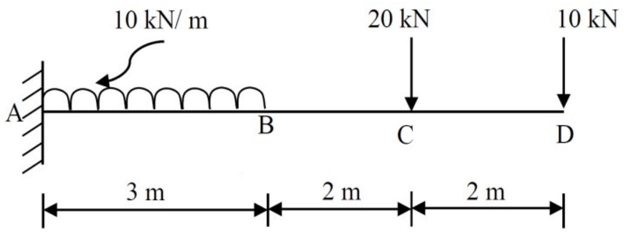
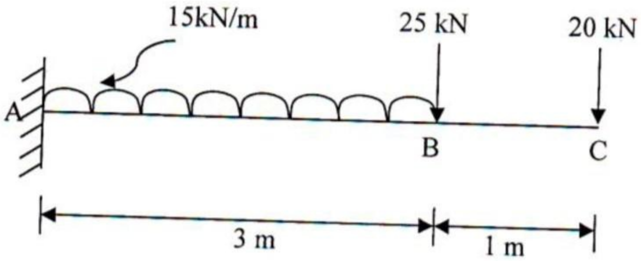


Figure 2



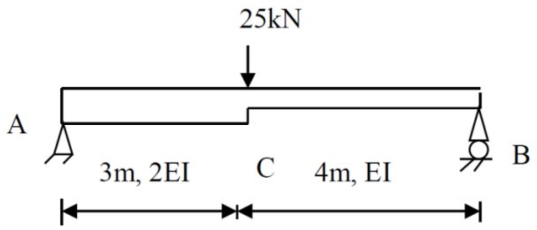


Figure 4

Figure 3

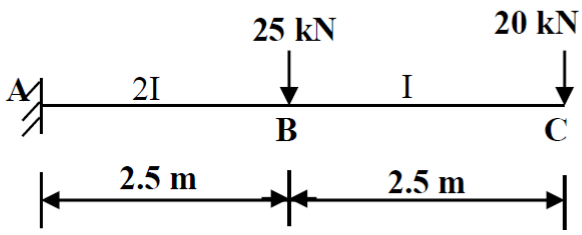


Figure 5

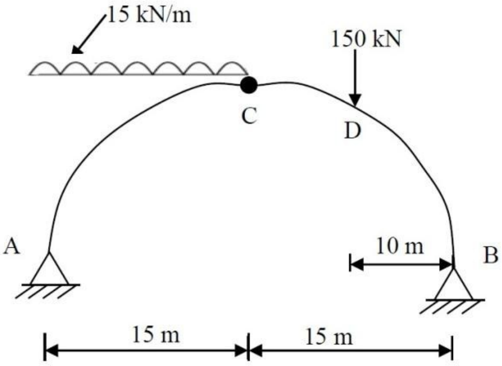
Assignment No. 3

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

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(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

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(c) The Castigliano's second theorem can be used to calculate deflections:

(i) At any point in a statically determinate structures only

(ii) At any point of any structure

(iii) at the point under the load in statically determinate structures only

(iv) at the point under the load of any structure

(d) The Betti's theorem of reciprocal work is valid for:

(i) Only beams

(ii) Beams and Frames

(iii) Beams, Frames and Trusses

(iv) Any linear structure, satisfying principle of superposition

(e) A three hinged arch is :

(i) Externally unstable

(ii) Externally & Internally unstable

(iii) Internally unstable

(iv) Externally & Internally stable

(f) When a unit rotation is given at the free end of a cantilever beam of flexural rigidity EI and length l, the moment produced at the fixed end will be

4. For the cantilever beam shown in Figure-3, obtain the Influence Line Diagrams (ILD) for the: (i) moment at A (ii) shear force at a distance of 3 m from A and (iii) bending moment at a distance of 5.5 m from A. Also determine the magnitude for these quantities, for the loading condition shown in the figure. 9+5=14

5. (i) What do you understand by a 'Funicular Arch'? Show that a three hinged symmetric parabolic arch of span l and rise h, *carrying* a uniformly distributed load per unit length of its span, may be considered to be a 'Funicular Arch'. (ii) A three-hinged semicircular arch of radius R carries a uniformly distributed load of w per unit run of the horizontal span. Find the horizontal thrust at each support as well as the location and magnitude of the maximum bending moment induced in the arch. Draw the bending moment diagram for the arch. 2+5+5+2=14

6. Analyze and obtain the axial force diagram (AFD), shear force diagram (SFD) and the bending moment diagram (BMD) for the frame shown in Figure-4. Also obtain the qualitative displacement curve for the frame. 12+2=14

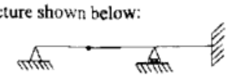
7. State and Prove Betti's Theorem of reciprocal work. Then show that Maxwell's Theorem of reciprocal displacements can be obtained from Bettis theorem, as a special case. Explain and prove Eddy's theorem for an Arch. 6+3+5=14

(ii) Length

(iii) force × length

(iv) force/length

(j) What is degree of static indeterminacy of the structure shown below:



(i) 1 (ii) 2 (iii) 3 (iv) 0

2. Determine the Internal, External and Total static Indeterminacy as well as stability for the structures shown in Figures [1-A) to (1-C)] . Also determine the Kinematic indeterminacy of the last two. 12+2+14

Figure (1-A) Figure (1-B) Figure (1-C)

3. Determine the member forces in the Truss shown in Figure-2, assuming the outer and the inner triangular panels (ABC & DEF) to be equilateral triangles of side lengths 5 m and 2 m, respectively and being placed concurrently. Also calculate the horizontal displacement of the joint B, by any method. 8+6=14

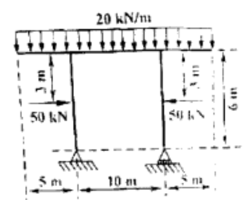


Figure-4

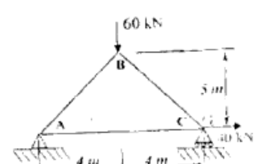


Figure-5

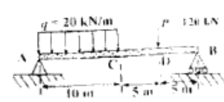


Figure-6

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8. For the simply supported plane truss shown in Figure-5, calculate the joint displacements in X and Y directions (horizontal & vertical), using *Matrix method of analysis*. Also obtain the forces induced in the members of the truss. Assume cross sectional area A = 500 mm^2 and Modulus of Elasticity E = 200 GPa, for all members of the truss. 9+5=14

9. Find the slopes at the supports of the simply supported beam shown in Figure-6, using the moment area method.

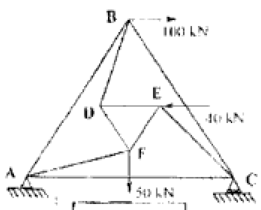


Figure-2

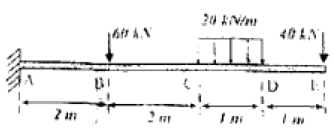


Figure-3

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

(j) 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

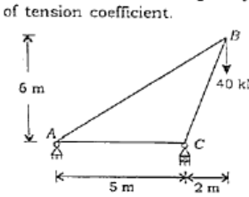


Fig. 1

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

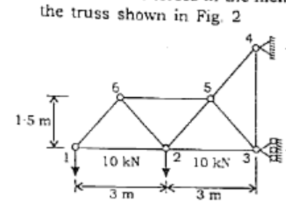


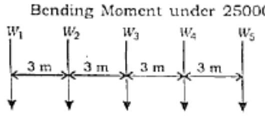
Fig. 2

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

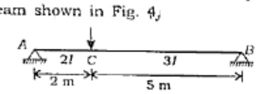


Fig. 4

7. (a) Explain with suitable sketch, the principle of virtual work and Castiglione'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

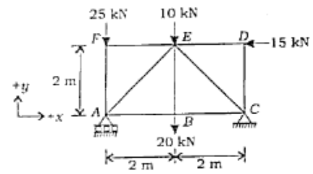


Fig. 5

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

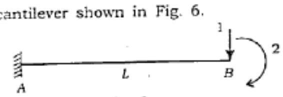


Fig. 6

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(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

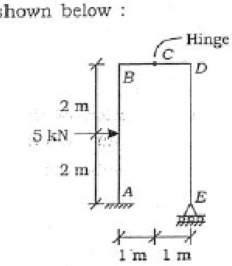
(i) EI/L

(ii) $2EI/L$

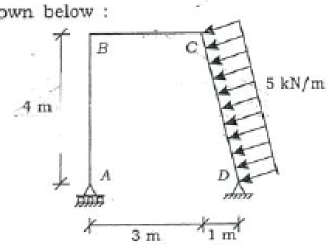
(iii) $3EI/L$

(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

(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

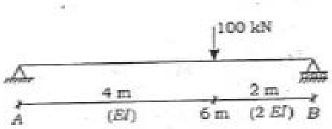
The fixed support in a read beam becomes —— in the conjugate beam.

(i) roller support

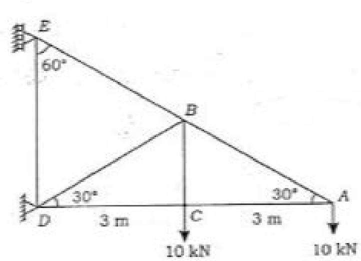
(ii) hinged support

(iii) free support

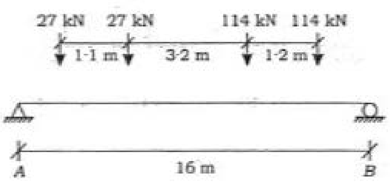
4. Calculate the maximum deflection in the beam and its location :



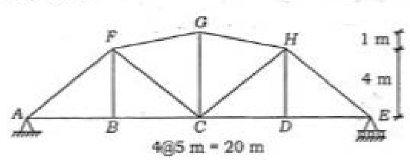
5. Determine the deflection of the point *A* of the truss $E = 2 \times 10^5$ N / mm^2 and *A* = cross section = 100 mm^2 (all the members) :



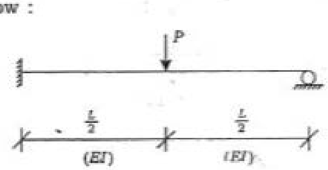
6. Determine the absolute maximum shear and moment for the beam as shown below, when a standard IRC class-A driving vehicle traverse in either direction :



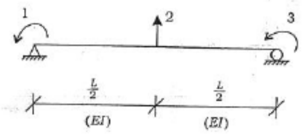
7. Draw the IL for the forces in members *CD*, *CH* and *GH* :



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



9. Generate the flexibility matrix f for the coordinates 1, 2 and 3 of the beam as shown below :



* * *

(g) A point load of 50 kN acting centrally on a simply supported beam produces the same maximum deflection in the beam as caused by a UDL of 20 kN/m over the whole span. The span of the beam is

(i) 10 m
(ii) 8 m
(iii) 6 m
(iv) 4 m

(h) If fixity of support increases in a simply supported beam, central deflection

(i) increases
(ii) decreases
(iii) does not change

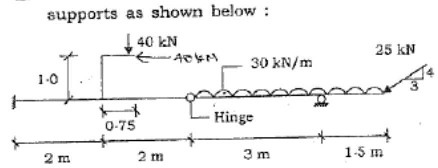
(i) Castigliano's theorem is applicable

(i) when the system behaves elastically
(ii) only when principle of superposition is valid
(iii) None of the above

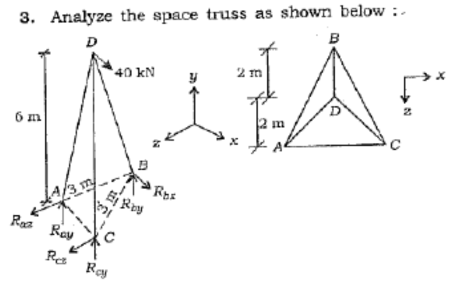
(j) The three-moment equation written for an intermediate support of a continuous beam expresses the condition of

(i) slope compatibility at that point
(ii) moment equilibrium at that point
(iii) zero deflection at the support point
(iv) structural stability

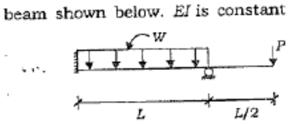
2. Determine the reaction components of the two supports as shown below :



3. Analyze the space truss as shown below :

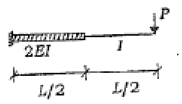


4. Determine the deflection under load point for the beam shown below. EI is constant :



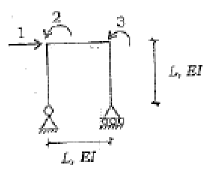
5. Write the theorem of three moments considering support settlement, explaining meaning of notations used.

6. Using energy equations, find the deflection under the load point of the beam.

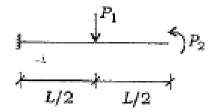


7. Two wheel loads, 160 kN and 90 kN, spaced 4 m apart, are moving over a simply supported beam of 12 m span. Determine the maximum shear force and moment that may be developed anywhere on the beam.

8. Generate flexibility matrix for coordinates 1, 2 and 3 of the frame.



9. Considering only bending deformation, determine the flexibility matrix f and stiffness matrix k of the section shown below. EI is constant :



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