Module (Course Syllabus) Catalogue

2022-2023

College/ Institute	Erbil Technical Engineering College	
Department	Highway & Bridges Engineering Department	
Module Name	Structural Analysis	
Module Code	STA503	
Degree	Technical Diploma ☐ Bachelor ■ High Diploma ☐ Master ☐ PhD ☐	
Semester	5th	
Qualification		
Scientific Title	Assistant Lecturer	
ECTS (Credits)	6	
Module type	Prerequisite ☐ Core ■ Assist. ☐	
Weekly hours		
Weekly hours (Theory)	(4)hr Class	(6)hr Workload
Weekly hours (Practical)	-	-
Number of Weeks	16	
Lecturer (Theory)	Hana Sherzad Aziz	
E-Mail & Mobile	hana.aziz@epu.edu.iq 07504918619	
Lecturer (Practical)	-	
E-Mail & Mobile	-	
Websites	https://academicstaff.epu.edu.iq/faculty/hana.aziz	

Course Book

Course Description	A structure refers to a system of connected parts used to support a load. Important examples related to civil engineering include buildings, bridges, and towers; and in other branches of engineering, ship and aircraft frames, tanks, pressure vessels, mechanical systems, and electrical supporting structures are important. When designing a structure to serve a specified function for public use, the engineer must account for its **safety, aesthetics, and serviceability**, while taking into consideration **economic and environmental** constraints. Often this requires several independent studies of different solutions before final judgment can be made as to which structural form is most appropriate. This design process is both creative and technical and requires a **fundamental knowledge of material properties and the laws of mechanics** which govern material response. Once a preliminary design of a structure is proposed, the structure must then be analysed to ensure that it has its required stiffness and strength. To analyse a structure properly, certain **idealizations must be made as to how the members are supported and connected together**. **The loadings are determined from codes and local specifications, and the forces in the members and their displacements are found using the theory of structural analysis**, which is the subject matter of this course. The results of this analysis then can be used to redesign the structure, accounting for a more accurate determination of the weight of the members and their size. Structural design, therefore, follows a series of successive approximations in which every cycle requires a structural analysis. In this course, the structural analysis is applied to civil engineering structures; however, the method of analysis described can also be used for structures related to other fields of engineering.
Course objectives	• To discuss some of the preliminary aspects of structural analysis. • To deal with various types of statically determinate structures. • To develop some methods to determine unknown aspects of indeterminate statically structures. • To find links between structural analysis subjects and real-life structural issues. • To understand structural behavior under loadings in real life after finding the linkage with the theoretical parts. • To evaluate different methods of analyzing indeterminate statically structure problems.
Student's obligation	All students are required to fulfil the following requirements: ➢ Attendance ➢ Participation in problem solving and class activities ➢ Doing homework

	➢ Participation in quiz ➢ Participation in exams ➢ Conducting projects ➢ Presenting seminars ➢ Preparing reports
Required Learning Materials	Lecture halls with data show equipment for lecture presentations, white board, overhead projector, posters and markers.

Evaluation

Task		Weight (Marks)	Due Week	Relevant Learning Outcome
Paper Review		0	0	
Assignments	Homework	10	3rd & 6th	
	Class Activity	2	2nd to 11th	
	Report	8	5th	
	Seminar	0	0	
	Essay	0	0	
	Project	8	9th	
Quiz		8	4th & 8th	
Lab.		0	0	
Midterm Exam		24	7th	
Final Exam		40	13th	
Total		100		

Specific learning outcome:

1. The phases of activity necessary to produce a structure are presented.
2. The importance of choosing an appropriate analytical model for a structure is discussed so that the forces in the structure may be determined with reasonable accuracy.
3. The procedures for analyzing statically determinate trusses using the method of joints and the method of Sections are developed.
4. Drawing the influence line for a statically determinate structure is discussed.
5. Enough insight is gained from the study of approximate methods so that one can judge what would be the best approximations to make when performing an approximate force analysis of a statically indeterminate structure.
6. The force or flexibility method to analyze statically indeterminate trusses, beams, and frames are applied.
7. The basic ideas for analyzing structures using the displacement method of analysis are outlined.
8. Application to multi-story frames is discussed.

Course References:	- Structural analysis by R.C. Hibbeler, 8th edition - Structural Analysis 1 by S S Bhavikatti, 4th edition - Structural Analysis by Aslam Kassimali, 4th edition - Structural Analysis 2 by S S Bhavikatti, 4th edition

Course topics (Theory)	**Week**	**Learning Outcome**
Types of structures and loads	1	• The basic types of structures, their components, and supports are introduced. • A brief explanation is given of the various types of loads that must be considered for an appropriate analysis and design.
Analysis of statically determinate structures	2	• The criteria necessary for structural stability are discussed. • The analysis of statically determinate, planar, pin-connected structures is presented.
Analysis of Statically Determinate Trusses	3	• The determinacy and stability of a truss are discussed. • The analysis of three forms of planar trusses is considered: simple, compound, and complex.
Analysis of Statically Determinate Beams and Frames	4	• The methods for finding these loadings at specified points along a member's axis and for showing the variation graphically using the shear and moment diagrams are developed.
Influence line for statically determinate structures	5	• The theory of influence line is applied to structures subjected to a distributed load or a series of concentrated forces, and specific applications to floor girders and bridge trusses are given. • The determination of the absolute maximum live shear and moment in a member is discussed.
Approximate analysis for statically indeterminate frames	6	• Some of the approximate methods used to analyse statically indeterminate trusses and frames are presented. These methods were developed on the basis of structural behaviour, and their accuracy in most cases compares favourably with more exact methods of analysis.
Deflection of statically indeterminate structures	7	• Determination of the elastic deflections of a beam using the method of double integration and two important geometrical methods, namely, the moment-area theorems and the conjugate-beam method are shown. • Double integration is used to obtain equations which define the slope and the elastic curve. The geometric methods provide a way to obtain the

		slope and deflection at specific points on the beam. Each of these methods has particular advantages or disadvantages, which will be discussed when each method is presented.
Analysis of statically indeterminate structures: the force method	8	• The force or flexibility method to analyse statically indeterminate trusses, beams, and frames are applied. • A method for drawing the influence line for a statically indeterminate beam or frame is presented
Displacement method of analysis: slope deflection equations	9 10	• The general equations of slope deflection are developed and then use them to analyse statically indeterminate beams and frames.
Displacement method of analysis: moment distribution	11 12	• The important definitions and concepts for moment distribution and then apply the method to solve problems involving statically indeterminate beams and frames are stated.
Practical Topics	**Week**	**Learning Outcome**
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

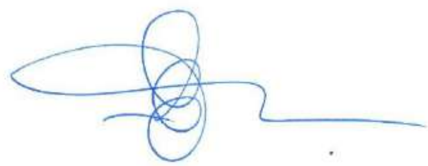
Questions Example Design

All questions are numerical and problem solving types. An example of a question paper and its solutions are attached at the end of this file.

Extra notes:

External Evaluator

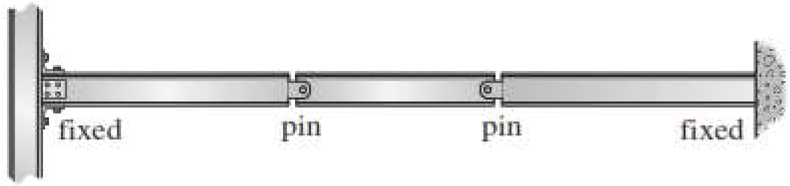
As an Assistant lecturer at Highway Department and PhD student in Civil Engineering, I have revised the module catalogue regarding the subject of Structural Analysis for the 3rd stage (5th semester), Department of Bridges and Highway Engineering, Erbil Technical Engineering College. I found that the course-module catalogue has described well enough the aim and objectives of the subject. Moreover, it covers all the required syllabus and contents of the course and describes satisfactorily the aspects related to the course.

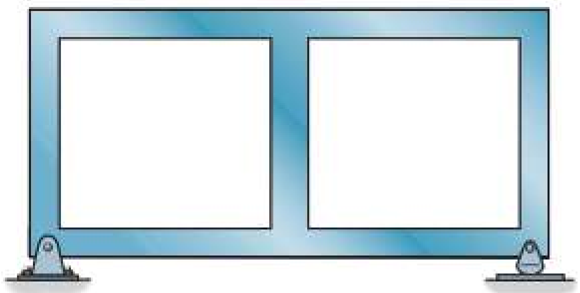


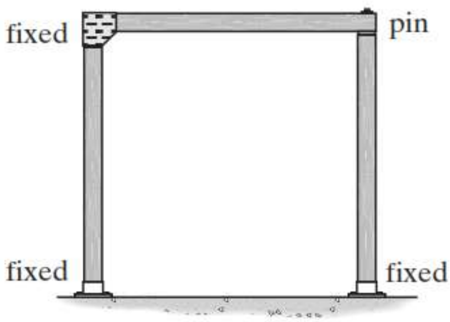
Ali Jamal Nouri
MSc Civil Engineering
Assistant Lecturer/Highway Engineering Department

Ministry of Higher Education & Scientific Research		**Class: Third**
Erbil Polytechnic University		**Subject: Structural Analysis**
		Code: STA502
Erbil Technical Engineering College		**Date: 12/12/2021**
Highway & Bridges Eng. Dept.	**Academic Year 2021 – 2022**	**Time: 120 min.**
Note: Answer all questions	**Final Exam عبور – 1st Attempt**	**Fifth Semester**

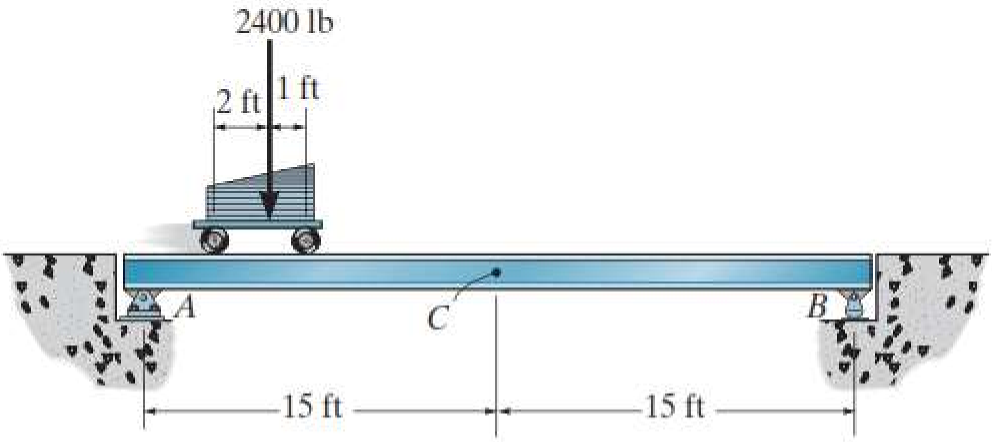
Q1/ Classify each of the structures as statically determinate, statically indeterminate, or unstable. If indeterminate, specify the degree of indeterminacy. **(20 Marks)**



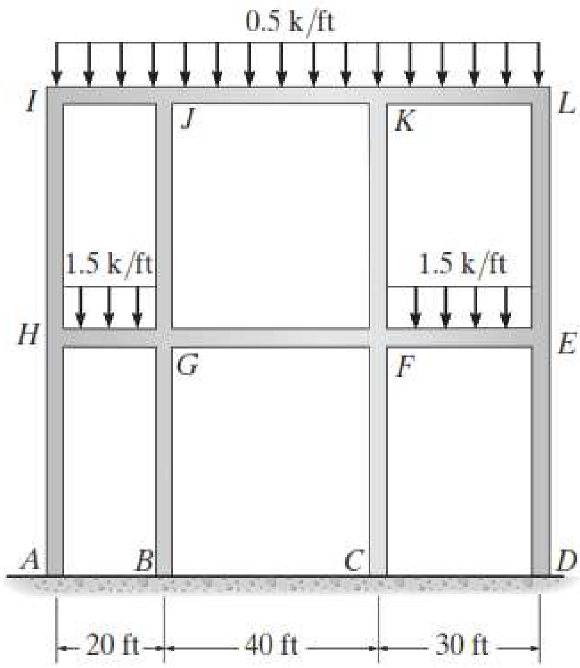




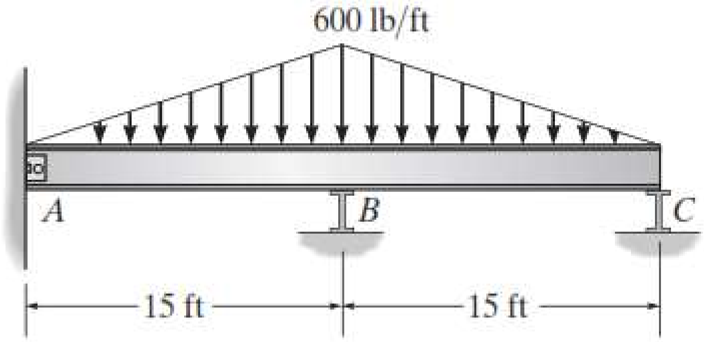
Q2/ Determine the maximum moment at C caused by the moving load. **(20 Marks)**



Q3/ Determine (approximately) the internal moments at joint I and L. Also, what is the internal moment at joint H caused by member HG? **(20 Marks)**



Q4/ Determine the reactions at the supports, then draw the moment diagram. Assume A is a pin and B and C are rollers. EI is constant. Use force method. **(20 Marks)**



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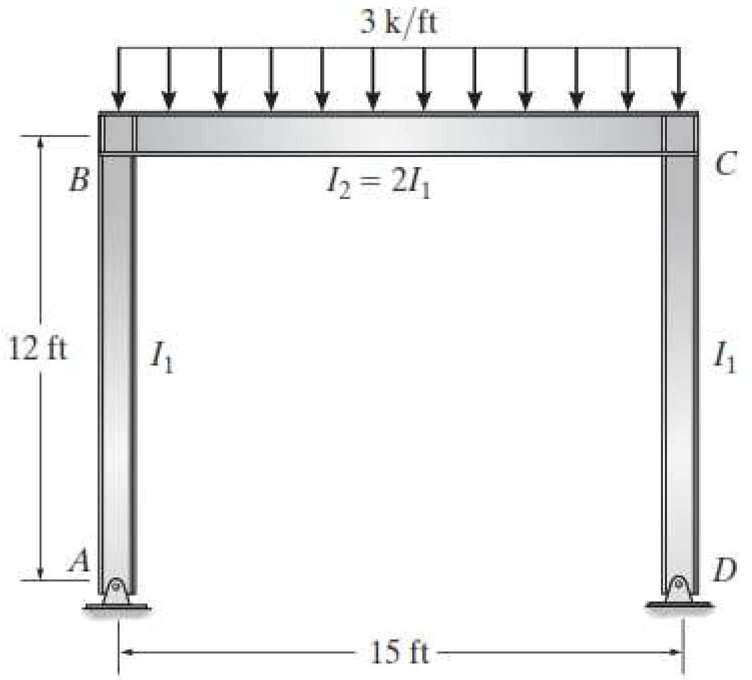
Q5/ The steel frame supports the loading shown. Determine the horizontal and vertical components of reaction at the supports A and D. Draw the moment diagram for the frame members. E is constant. **(20 Marks)**



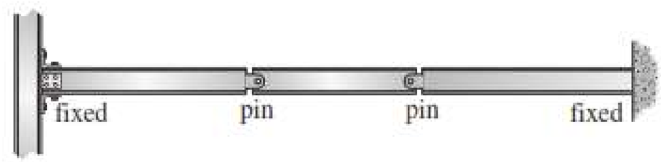
<u>Good Luck</u>

Dr. Ghafur Ahmed Head of Department	Assist. Lecturer: Hana Sherzad Examiner

Structural Analysis

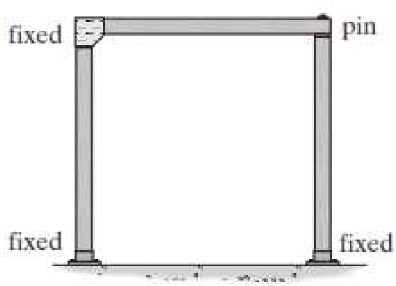
Solutions of Final – 1st Attempt

Q1



$r = 10 \qquad 3n = 3(3) < 10$

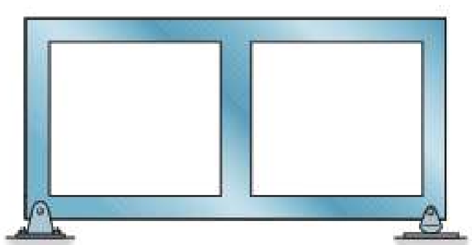
Statically indeterminate to 1°.



$r = 8 \qquad 3n = 3(2) = 6$

$r - 3n = 8 - 6 = 2$

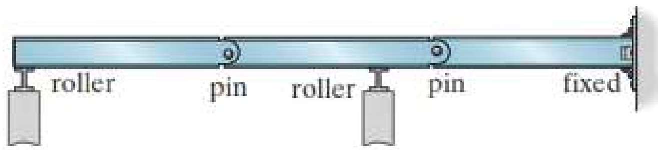
Stable and statically indeterminate to the second degree.



$r = 12 \qquad 3n = 3(2) = 6 \qquad r > 3n$

$r - 3n = 12 - 6 = 6$

Stable and statically indeterminate to the sixth degree.



$r = 9 \qquad 3n = 3(3) = 9$

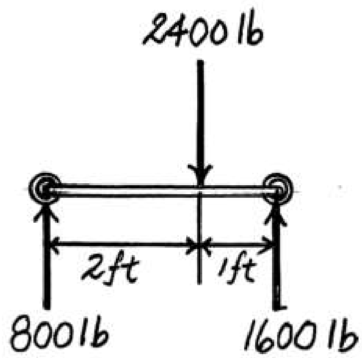
$r = 3n$

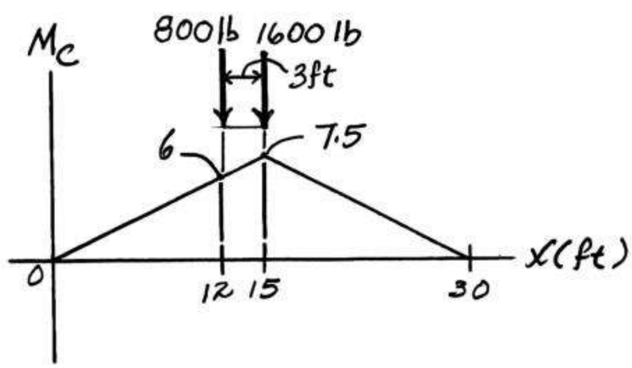
Stable and statically determinate.

Q2

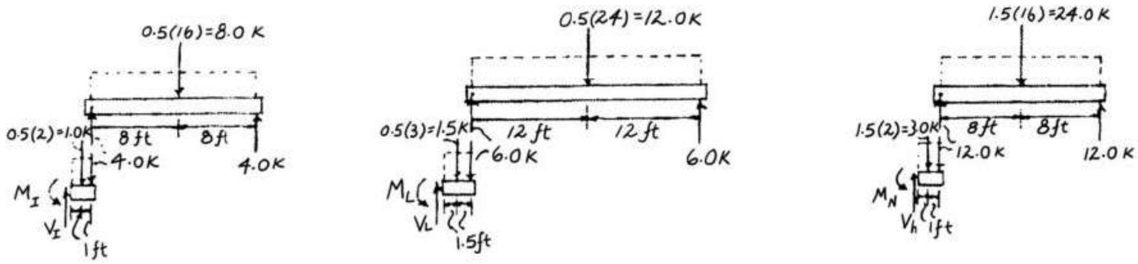
The vertical reactions of the wheels on the girder are as shown. The maximum positive moment at point C occurs when the moving loads are at the position shown

$$(M_C)_{\max(+)} = 7.5(1600) + 6(800) = 16800 \text{ lb} \cdot \text{ft}$$
$$= 16.8 \text{ k} \cdot \text{ft}$$





Q3



Joint *I*:

$$\circlearrowleft + \sum M_I = 0; \qquad M_I - 1.0(1) - 4.0(2) = 0$$

$$M_I = 9.00 \text{ k} \cdot \text{ft}$$

Joint *L*:

$$\circlearrowleft + \sum M_L = 0; \qquad M_L - 6.0(3) - 1.5(1.5) = 0$$

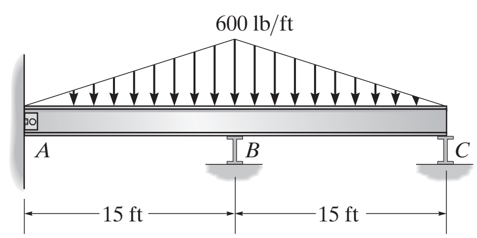
$$M_L = 20.25 \text{ k} \cdot \text{ft}$$

Joint *H*:

$$\circlearrowleft + \sum M_H = 0; \qquad M_H - 3.0(1) - 12.0(2) = 0$$

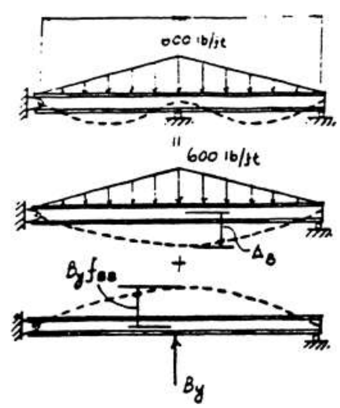
$$M_H = 27.0 \text{ k} \cdot \text{ft}$$

Q4



Compatibility Equation:

$$(+\downarrow) \qquad \Delta_B - B_y f_{BB} = 0 \qquad (1)$$



Use virtual work method:

$$\Delta_B = \int_0^L \frac{mM}{EI}dx = 2\int_0^{15} \frac{(4.5x - 0.00667x^3)(-0.5x)}{EI}dx = -\frac{4050}{EI}$$

$$f_{BB} = \int_0^L \frac{mm}{EI}dx = 2\int_0^{15} \frac{(-0.5x)^2}{EI}dx = \frac{562.5}{EI}$$

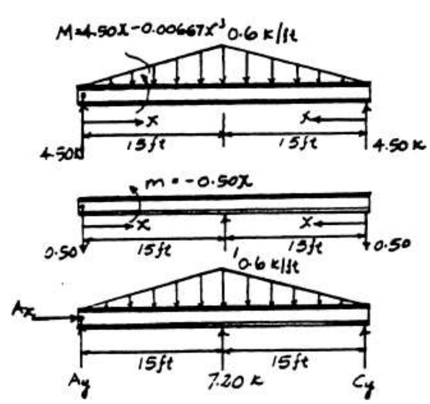
From Eq. 1 $\quad \dfrac{4050}{EI} - B_y \dfrac{562.5}{EI} = 0$

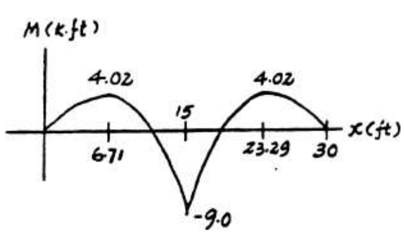
$B_y = 7.20\,\text{k}$ **Ans.**

$A_y = 0.900\,\text{k}$ **Ans.**

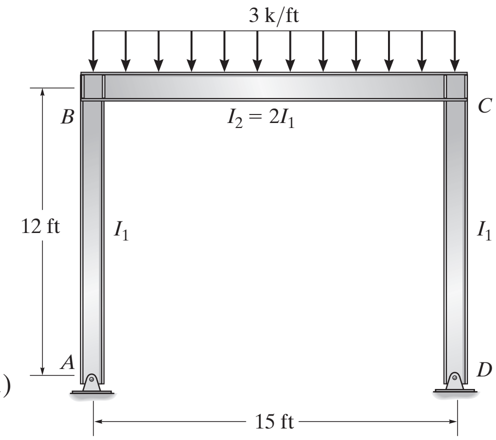
$A_x = 0$ **Ans.**

$C_y = 0.900\,\text{k}$ **Ans.**





Q5



Compatibility Equation:

$$\Delta_D + D_x f_{DD} = 0 \qquad (1)$$

Use virtual work method:

$$\Delta_D = \int_0^L \frac{mM}{EI}dx = 0 + \int_0^{15} \frac{12(22.5x - 1.5x^2)}{E(2I_1)}dx + 0 = \frac{5062.5}{EI_1}$$

$$f_{DD} = \int_0^L \frac{mm}{EI}dx = 2\int_o^{12} \frac{(1x)^2}{EI_1}dx + \int_0^{15} \frac{(12)^2}{E(2I_1)}dx = \frac{2232}{EI_1}$$

From Eq. 1

$$\frac{5062.5}{EI_1} + D_x \frac{2232}{EI_1} = 0$$

$D_x = -2.268 \text{ k} = -2.27 \text{ k}$ **Ans.**

$\circlearrowleft + \sum M_A = 0; \quad -45(7.5) + D_y(15) = 0 \qquad D_y = 22.5 \text{ k}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad 22.5 - 45 + A_y = 0; \qquad A_y = 22.5 \text{ k}$ **Ans.**

$\xrightarrow{+} \sum F_x = 0; \quad A_x - 2.268 = 0; \qquad A_x = 2.27 \text{ k}$ **Ans.**