Module 5 : Force Method - Introduction and applications

Lecture 5 : Tutotial Problems

Objectives

In this course you will learn the following

- Some tutorial problems related to this module.

TUTORIAL PROBLEMS

T5.1 Determine the support reactions of the propped cantilever beam as shown in Figure T5.1. Use moment area method and verify by conjugate beam method.

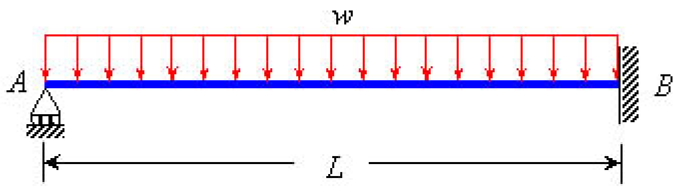


Figure T5.1

T5.2 Determine the support reactions of the propped cantilever beam as shown in Figure T5.2. Use moment area method or conjugate beam method.

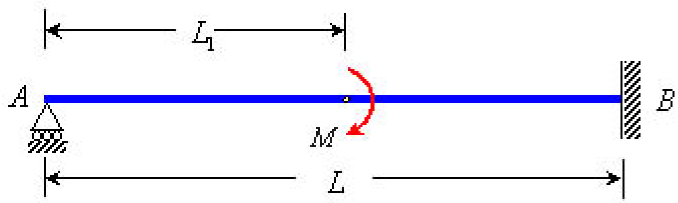


Figure T5.2

T5.3 Determine the shear in the internal hinge and support reactions of the fixed beam shown in Figure T5.3

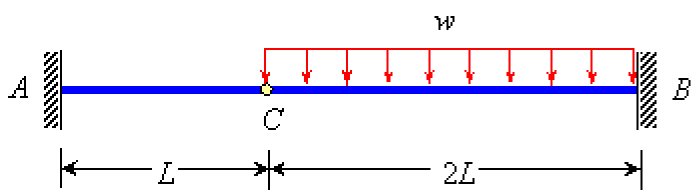


Figure T5.3

T5.4 Determine the force in the spring of the beam shown in Figure T5.4.

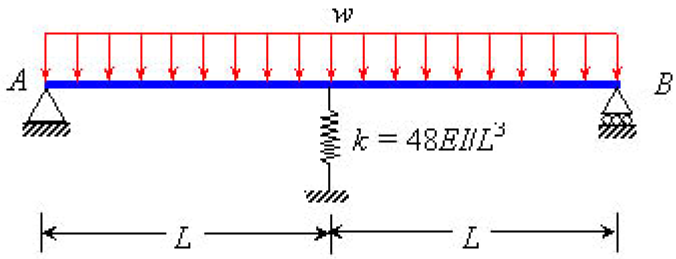


Figure T5.4

T5.5 Determine the reaction at the prop end of the cantilever beam shown in the Figure T5.5.

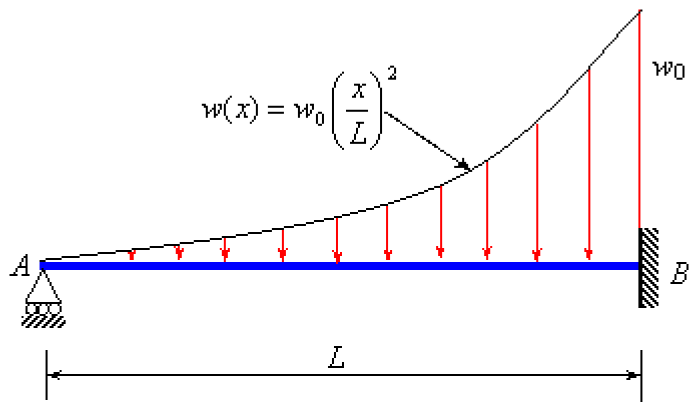


Figure T5.5

T5.6 Determine the support reactions of the propped cantilever beam (Figure T5.6) if support *A* settle downward by an amount of Δ. Take flexural rigidity of member *AB* as *EI* . Member *BC* is rigid.

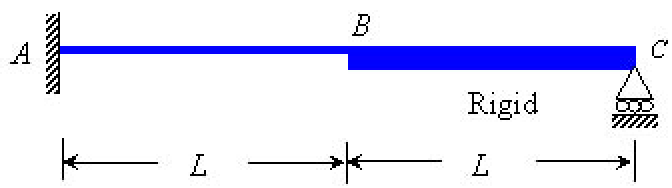


Figure T5.6

T5.7 Determine the support reactions of the uniform continuous beam as shown in Figure T5.7. At *B* there is an internal hinge.

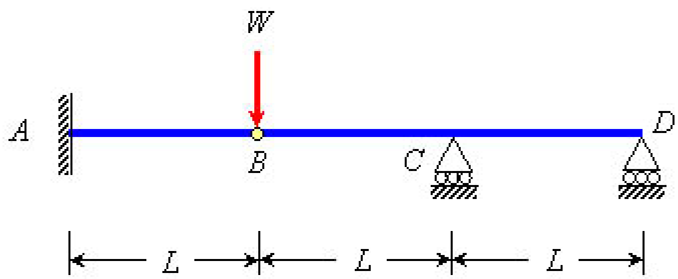


Figure T5.7

T5.8 Determine the force in the spring of the beam shown in Figure T5.8. The beam *ABC* is uniform with flexural rigidity *EI* . The stiffness of the spring is $48EI/7L^3$.

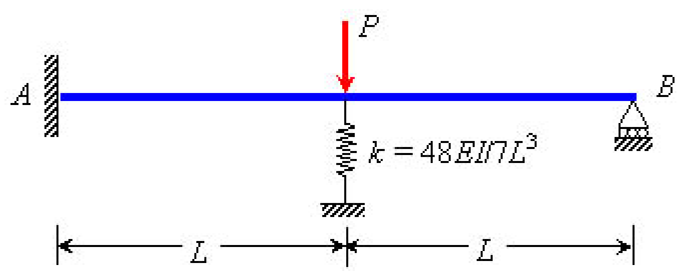


Figure T5.8

T5.9 Analyze the fixed beam shown in Figure T5.9.

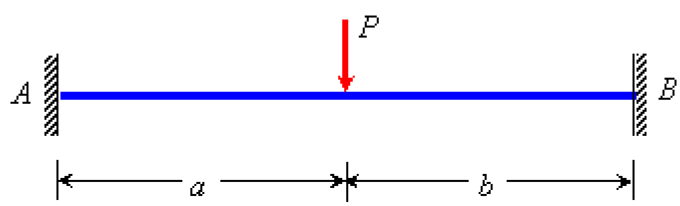


Figure T5.9

T5.10 Determine the support reactions of the fixed beam shown in Figure T5.10.

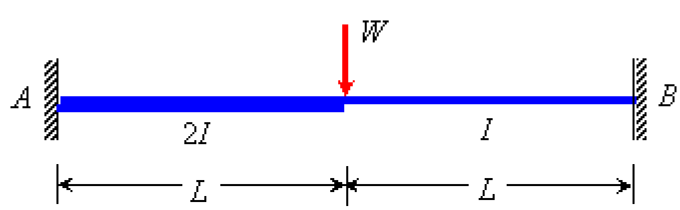


Figure T5.10

T5.11 Determine the support reactions of continuous beam shown in Figure T5.11.

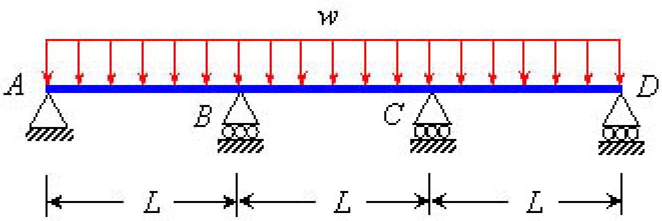


Figure T5.11

T5.12 Determine the force in various members of the pin-jointed structure as shown in Figure T5.12. All the members of the frame have the same axial rigidity, *AE* .

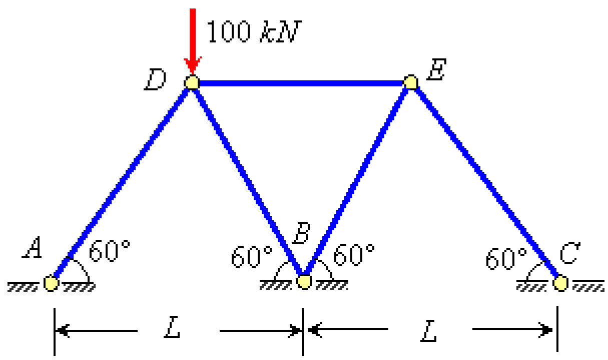


Figure T5.12

T5.13 Determine the force in various members of the pin-jointed structure as shown in Figure T5.13, if the temperature in the member *BC* rises by an amount ΔT. All the members of the frame have the same length, *L* and axial rigidity, *AE* . Take coefficient of thermal expansion as α.

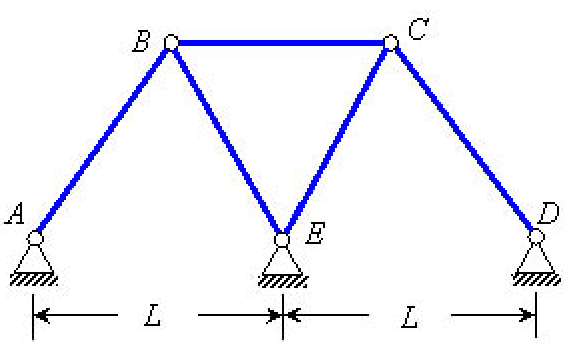


Figure T5.13

T5.14 Determine the force in various members of the pin-jointed frame as shown in Figure T5.14. All members of the frame have same axial rigidity as *AE* .

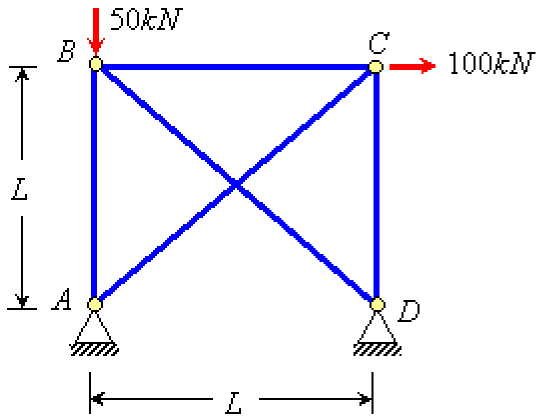
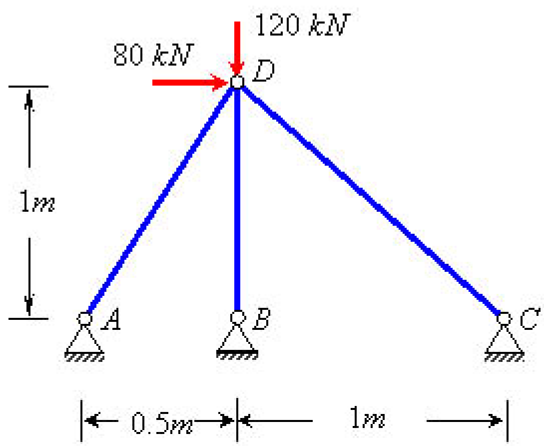


Figure T5.14

T5.15 Determine the force in various members of the pin-jointed frame as shown in Figure T5.15. Take $AE = 9 \times 10^5$ **kN for all members.**



T5.16 Determine the support reactions of the rigid-jointed plane frame as shown in Figure T5.16. Both members of the frame have the same flexural rigidity as *EI* .

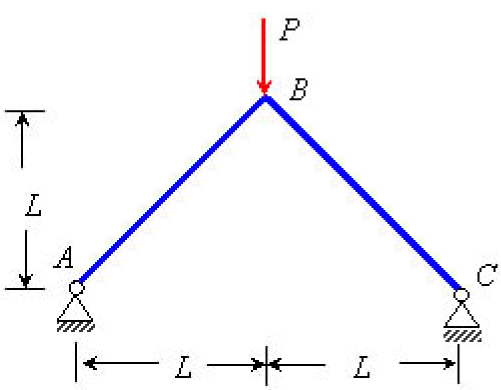


Figure T5.16

T5.17 Determine the support reactions of the rigid-jointed plane frame as shown in Figure T5.17 if the member *BC* is too long by an amount Δ **from the original length. Both the members of the frame have the same length and flexural rigidity.**

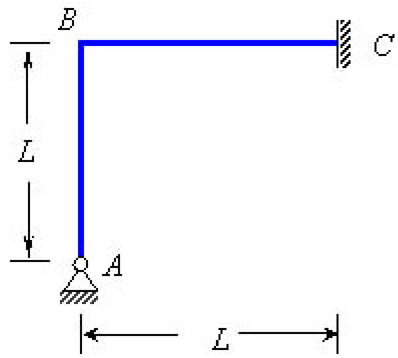


Figure T5.17

T5.18 Determine the support reactions in the rigid-jointed plane frame as shown in Figure T5.18. Note that the member *AB* has an $EI = 500\ \mathrm{kN.m^2}$ **and for member *BC* the *EI* =** ∞**.**

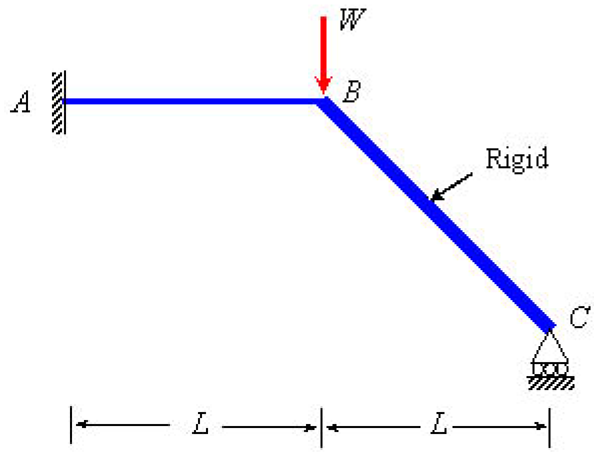


Figure T5.18

T5.19 Determine the support reactions of rigid-jointed plane frame as shown in Figure T5.19. All members of frame have same flexural rigidity.

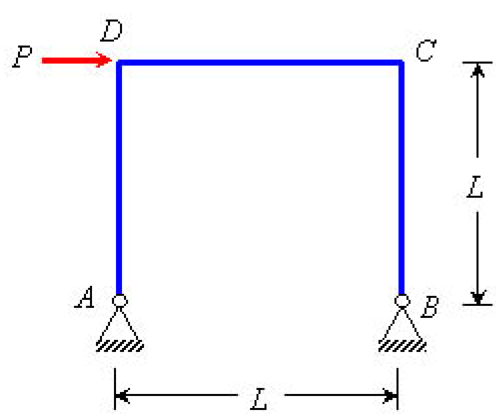


Figure T5.19

T5.20 Determine the support reactions of the rigid-jointed plane frame as shown in Figure T5.20, if the member BC is assumed to be subjected to a linear temperature gradient such that the top surface of the beam is at temperature T_2 **and lower at** T_1 **. The beam is uniform having flexural rigidity as *EI* and depth *d* . The coefficient of thermal expansion for beam material is a .**

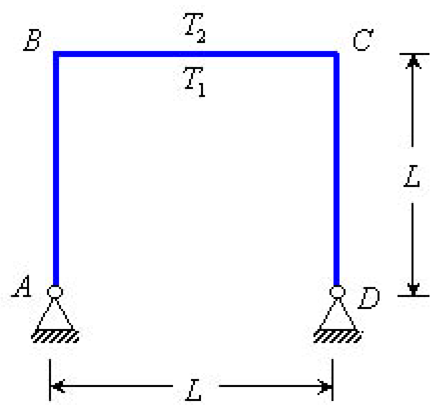


Figure T5.20

T5.21 Determine the support reactions of the rigid-jointed plane frame as shown in Figure T5.21.

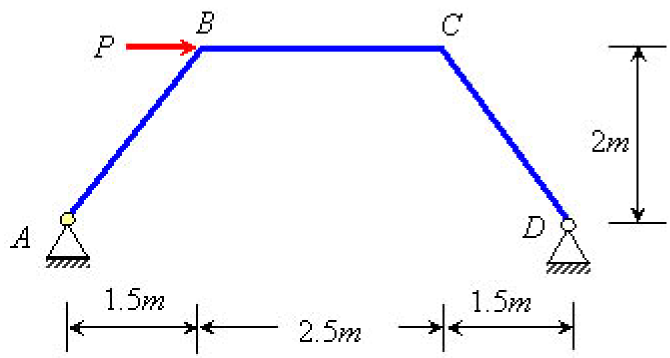


Figure T5.21

T5.22 Using theorem of three moment find the reactions of the uniform beam shown in Figure T5.22.

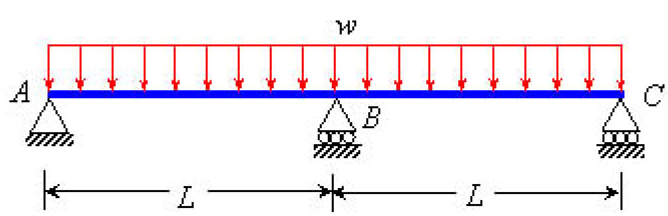


Figure T5.22

T5.23 Using theorem of three moments, determine the reactions of the uniform continuous beam shown in Figure T5.23.

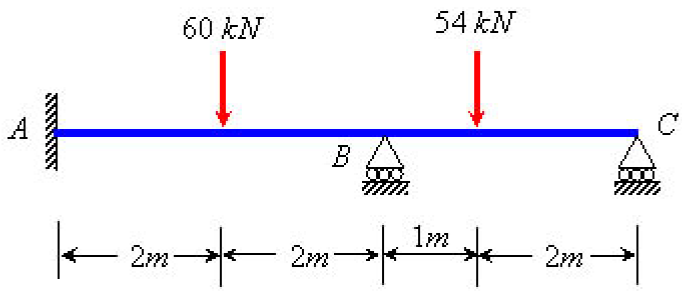


Figure T5.23

T5.24 Using the theorem of three moments analyze the uniform continuous beam shown in Figure T5.24.

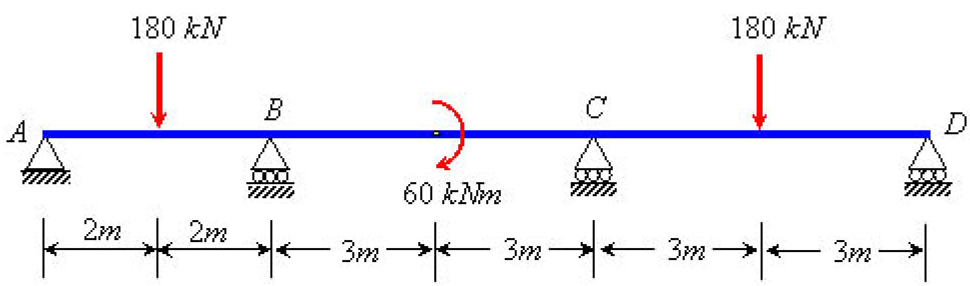


Figure T5.24

T5.25 Using the theorem of three moments, determine the support reaction, if support *B* settles down by an amount Δ. Take the flexural rigidity of the entire beam as *EI* .

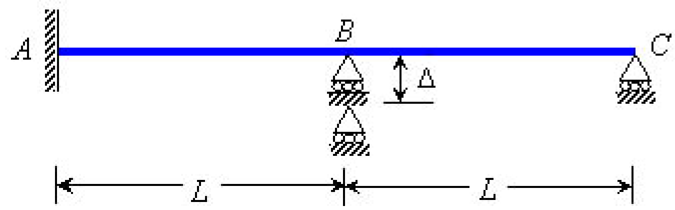


Figure T5.25

Recap

In this course you have learnt the following

- You have learned some tutorial problems related to this module.

Answers of tutorial problems

T5.1 $V_A = \frac{3wL}{8} (\uparrow)$

and

$$V_B = \frac{5wL}{8}\,(\uparrow) \qquad M_B = \frac{wL^2}{8}\,(\circlearrowright)$$

T5.2 $$V_A = \frac{3M(L^2 - L_1^2)}{2L^3}\,(\downarrow)$$

$$V_B = \frac{3M(L^2 - L_1^2)}{2L^3}\,(\uparrow) \quad \text{and} \quad M_B = \frac{M(L^2 - 3L_1^2)}{2L^2}\,(\circlearrowright)$$

T5.3 $$V_A = \frac{2wL}{3}\,(\uparrow)$$

$$V_C = \frac{2wL}{3}$$

$$V_B = \frac{4wL}{3}$$

$$M_A = \frac{2wL^2}{3}\,(\circlearrowleft) \quad \text{and} \quad M_B = \frac{2wL^2}{3}\,(\circlearrowright)$$

T5.4 $$F_s = \frac{10wL}{9}$$

T5.5 $$V_A = \frac{w_0 L}{24}$$

T5.6 $$V_A = \frac{3EI\Delta}{7L^3}\,(\downarrow)$$

$$M_A = \frac{6EI\Delta}{7L^2}\,(\circlearrowright) \quad \text{and} \quad V_C = \frac{3EI\Delta}{7L^3}\,(\uparrow)$$

T5.7 $$V_A = \frac{2W}{3}\,(\uparrow)$$

$$M_A = \frac{2WL}{3}\,(\circlearrowleft)$$

$$V_C = \frac{2W}{3}\,(\uparrow)$$

$$V_D = \frac{W}{3}\,(\downarrow)$$

T5.8 $$F_s = \frac{P}{3}$$

T5.9 $$M_A = \frac{Pab^2}{(a+b)^2}\,(\circlearrowleft) \quad \text{and} \quad M_B = \frac{Pba^2}{(a+b)^2}\,(\circlearrowright)$$

T5.10 $V_A = \dfrac{6W}{11}\,(\uparrow)$

$M_A = \dfrac{10WL}{33}\,(\circlearrowleft)$

$V_B = \dfrac{5W}{11}\,(\uparrow)$

$M_B = \dfrac{7WL}{33}\,(\circlearrowright)$

T5.11 $V_A = V_D = \dfrac{2wL}{5}\,(\uparrow)$ and $V_B = V_C = \dfrac{11wL}{10}\,(\uparrow)$

Member	Force
AD	$100\sqrt{3}$ (C)
BD	$100\sqrt{3}$ (C)
DE	0
BE	0
CE	0

T5.12

T5.13

Member	Force
AB	$AE\alpha\Delta T/5$ (C)
BC	$AE\alpha\Delta T/5$ (C)
BE	$AE\alpha\Delta T/5$ (T)
CD	$AE\alpha\Delta T/5$ (C)
CE	$AE\alpha\Delta T/5$ (T)

T5.14

Member	Force
AB	0
BC	50 (T)
CD	– 50 (T)
AC	$50\sqrt{2}$ (T)
BD	$-50\sqrt{2}$ (T)

T5.15

Member	Force
AD	13.585 (T)
BD	58.248 (C)
CD	104.6 (C)

T5.16

$$V_A = V_C = \frac{P}{2}(\uparrow)$$

$$H_A = \frac{P}{2}(\rightarrow) \quad \text{and} \quad H_C = \frac{P}{2}(\leftarrow)$$

T5.17

$$V_A = \frac{18EI\Delta}{7L^3}(\uparrow)$$

$$H_A = \frac{12EI\Delta}{7L^3}(\rightarrow)$$

$$V_C = \frac{18EI\Delta}{7L^3}(\downarrow)$$

$$H_C = \frac{12EI\Delta}{7L^3}(\leftarrow)$$

$$M_C = \frac{6EI\Delta}{7L^2}(\circlearrowleft)$$

T5.18 $V_A = \frac{11W}{14}(\uparrow)$

$$M_A = \frac{2WL}{7}(\circlearrowleft) \quad \text{and} \quad V_C = \frac{5W}{14}$$

T5.19 $V_A = P(\downarrow)$

$$H_A = \frac{P}{2}(\leftarrow)$$

$$V_B = P(\uparrow)$$

$$H_B = \frac{P}{2}(\leftarrow)$$

T5.20 $V_A = V_D = 0$

$$H_A = \frac{3EI\alpha(T_2 - T_1)}{5dL}(\leftarrow) \quad \text{and} \quad H_D = \frac{3EI\alpha(T_2 - T_1)}{5dL}(\rightarrow)$$

T5.21 $V_A = \frac{4P}{11}(\downarrow)$

$$H_A = \frac{P}{2}(\leftarrow)$$

$$V_D = \frac{4P}{11}(\uparrow)$$

$$H_D = \frac{P}{2}(\leftarrow)$$

T5.22 $V_A = V_C = \dfrac{3wL}{8}(\uparrow)$ and $V_B = \dfrac{5wL}{4}(\uparrow)$

T5.23 $V_A = 30\ kN\ (\uparrow)$

$$M_A = 30\ kNm\ (\circlearrowleft)$$

$$V_B = 76\ kN\ (\uparrow)$$

$$V_C = 8\ kN\ (\uparrow)$$

T5.24 $V_A = 85.135\ kN\ (\uparrow)$

$$V_B = 71.42\ kN\ (\uparrow)$$

$$V_C = 130.135\ kN\ (\uparrow)$$

$$V_D = 73.311\ kN\ (\uparrow)$$

T5.25 $V_A = \dfrac{66EI\Delta}{7L^3}(\uparrow)$

$$M_A = \frac{36EI\Delta}{7L^2}(\circlearrowleft)$$

$$V_B = \frac{96EI\Delta}{7L^3}(\downarrow)$$

$$V_C = \frac{30EI\Delta}{7L^3}(\uparrow)$$