



UNIVERSITI KUALA LUMPUR
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE : SCB36203 (V1)
COURSE TITLE : AUTOMOTIVE STRUCTURE
PROGRAMME NAME : BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN
MECHANICAL (AUTOMOTIVE)
DATE : 28 JANUARY 2026
TIME : 2:00PM - 5:00PM
DURATION : 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of ONE sections.
4. Section A consist of five questions. Answer FOUR (4) questions only.
5. Please write your answer on the answer booklet provided.
6. Please answer all questions in English only.
7. Refer to the attached Formula/ Appendices. Tick if applicable

THERE ARE 11 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 100 marks)

Answer FOUR (4) questions.

Please use the answer booklet provided.

Question 1

Chapter 1: Vehicle Body Design

- (a) An automotive structure is the vehicle's skeleton.
- Explain two main purposes of an automotive structure. (4 marks)
 - Vehicle chassis come in main types and each offering different strength, weight, and performance trade-offs for various applications. List five common vehicle chassis type. (5 marks)
- (b) Front bumper function is to absorb impact during collision and following figure show the location of a front bumper in a car. If the beam thickness is 3mm and the steel's elastic modulus is 200GPa, determine all the following.
Refer Below - Figure1 : Front beam at car structure .

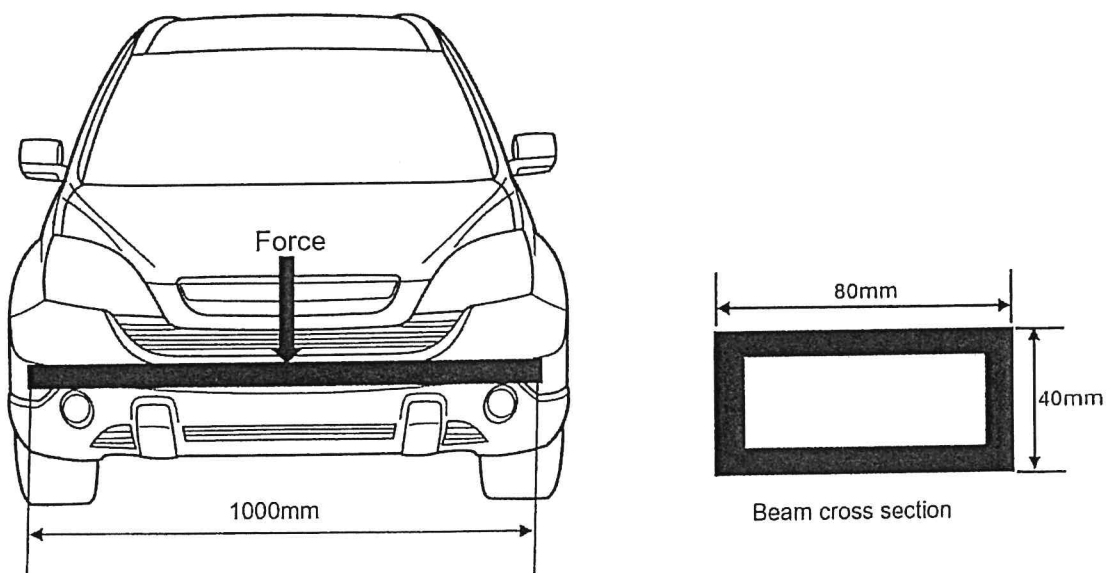


Figure 1: Front beam at car structure

- i. The beam moment of inertia.
(6 marks)
- ii. The bending stiffness of the front beam.
(6 marks)
- iii. The deflection of the front beam if the force acting on it is below 9kN.
(4 marks)

Question 2

Chapter 2: Vehicle Load & Estimation

- (a) The figure below shows all major body system in a car structure.
Name the following components that are labelled *i*, *ii*, *iii*, *iv* and *v* in the figure.
Refer Below - Figure2 : Major body system in a car structure .

(5 marks)

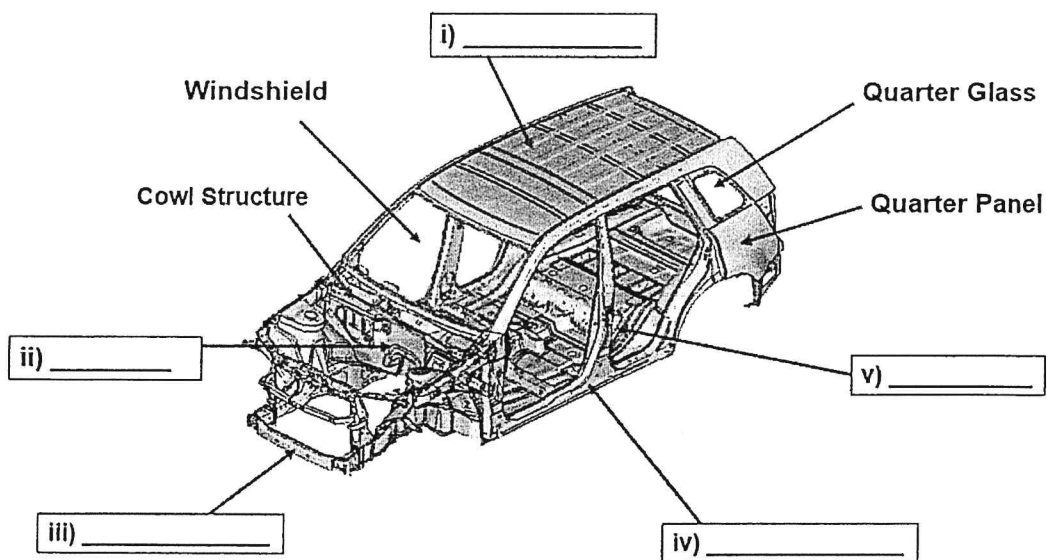


Figure 2: Major body system in a car structure

- (b) Figure below shows the total dimension of load distribution of a Perodua Bezza. The occupant in the car consists of 2 people at front seat and 3 people at rear seat. If the load distribution is simplified in the table below and all the length dimensions is in mm, determine:

Refer Below - Figure3 : Perodua Bezza load distribution . Table1 : Perodua Bezza load distribution .

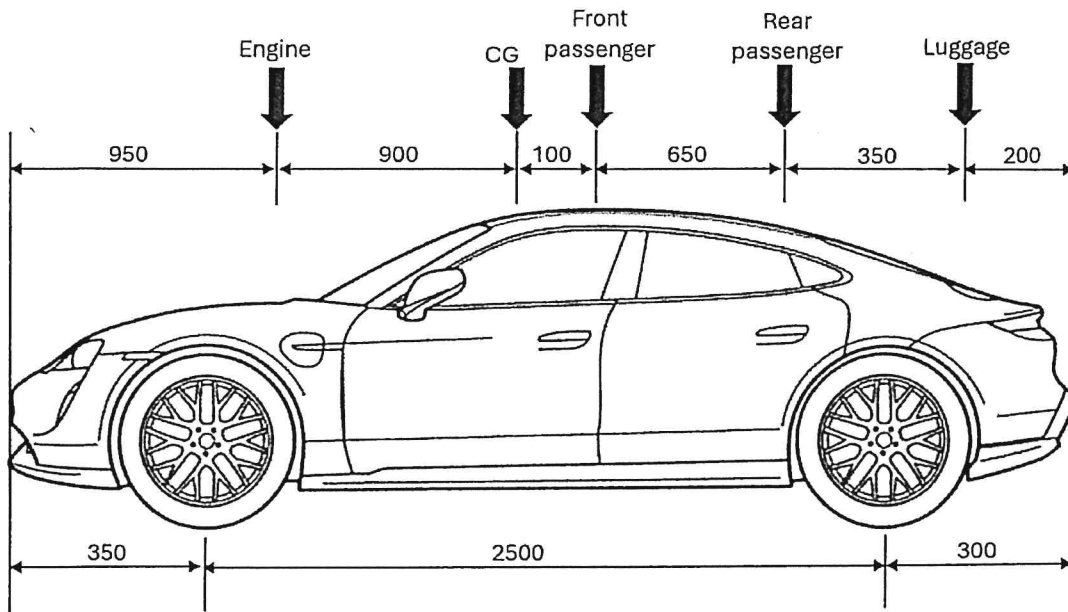


Figure 3: Perodua Bezza load distribution

Table 1: Perodua Bezza load distribution

Load item	Mass, kg
Engine	380
Total mass of the structure	800
Average mass of an occupant	65
Total mass of the luggage	80

- i. The shear force distribution throughout the structure. (5 marks)
- ii. The reaction force at the front and rear axle. (4 marks)
- iii. The bending moment distribution of the structure from FRONT AXLE to REAR PASSENGER only. (11 marks)

Question 3

Chapter 3: Structural Analysis

(a) The vehicle structure forms the foundation of the entire vehicle, and it is very important parts in a vehicle.

i. State and explain three main requirements for the vehicle structure.

(6 marks)

ii. Name any three basic global load cases acting on a vehicle structure.

(3 marks)

(b) A cylinder weighing 20kg is held against a smooth incline surface by means of the weightless rod AB as in figure below.

Refer Below - Figure4 : Cylinder attached at rod AB and incline surface .

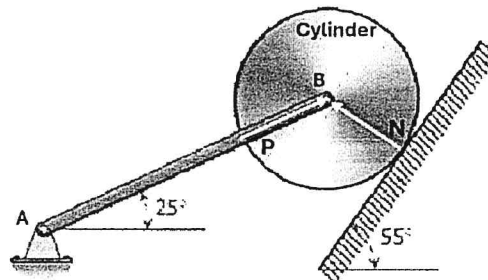


Figure 4: Cylinder attached at rod AB and incline surface

i. Sketch the free body diagram of the system components.

(2 marks)

ii. Determine the force N exerted on the cylinder by the rod and the incline surface.

(6 marks)

(c) Two weightless beams are pinned together to support a 35kN load as in figure below.

Refer Below - Figure5 : Beams pinned together .

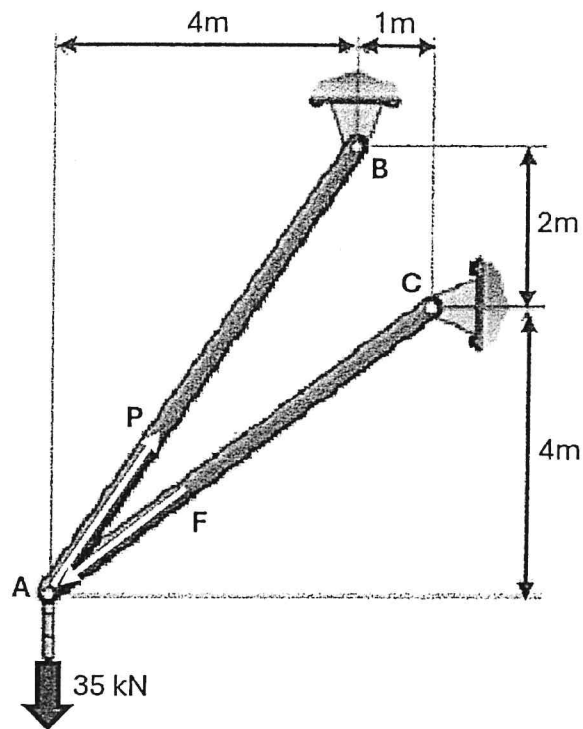


Figure 5: Beams pinned together

- i. Sketch the free body diagram of the system components.

(2 marks)

- ii. Determine the forces P and F acting respectively along beams AB and AC that maintain equilibrium of pin A.

(6 marks)

Question 4

Chapter 4: Simple Structure Surfaces

- (a) Figure below shows typical load distribution for a Porsche. Calculate:
 Refer Below - Figure6 : Load distribution for a Porsche .

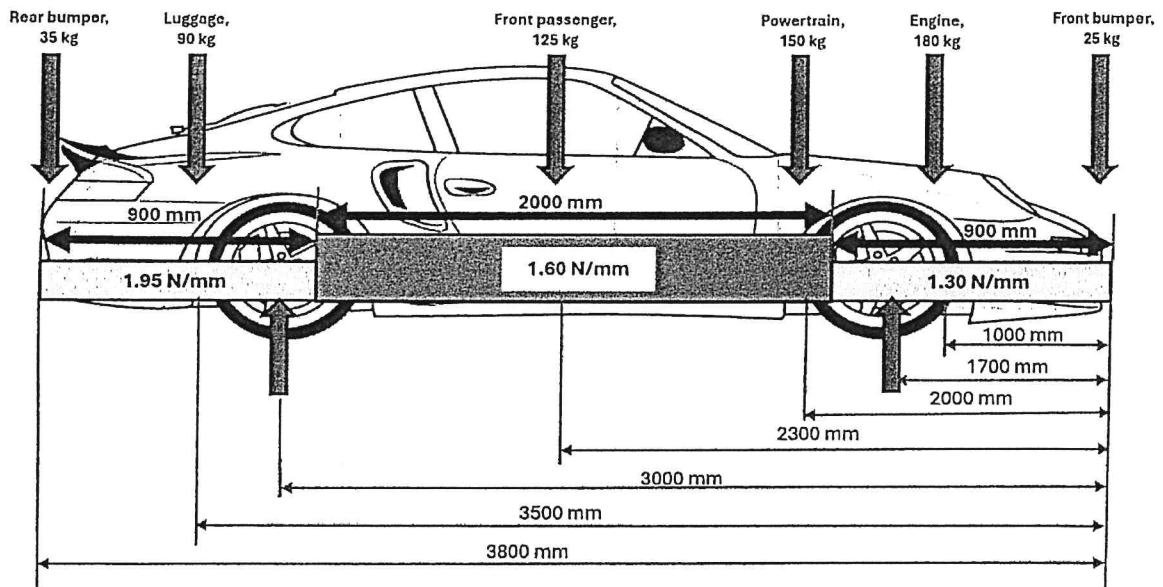


Figure 6: Load distribution for a Porsche

- i. All the load distribution for the whole car in table below.

Refer Below - Table2 : Load distribution for a Porsche .

(2 marks)

Table 2: Load distribution for a Porsche

Component	Mass, kg	Load, N	Distance, mm	Load X Distance, N.mm
Front bumper	25	245.25	0	
Engine	180	1765.8	1000	
Powertrain	150	1471.5	2000	
Front passenger	125	1226.25	2300	
Luggage	90	882.9	3500	
Rear bumper	35	343.35	3800	
Front structure	1.3 N/mm	1170	450	
Passenger compartment	1.6 N/mm	3200	1900	
Rear structure	1.95 N/mm	1755	3350	
TOTAL				

- ii. The longitudinal position of centre of gravity for the car.

(2 marks)

iii. The rear axle load of the car.

(4 marks)

iv. The front axle load of the car.

(2 marks)

(b) A sedan car structure is simplified based on simple structure surfaces (SSS) construction given in the figure below. If the car structure is supported at all four corners by tires, calculate all the forces and reaction forces on all 6 surfaces of the box structure.

Refer Below - Figure7 : Simple structure surfaces of a sedan car .

(15 marks)

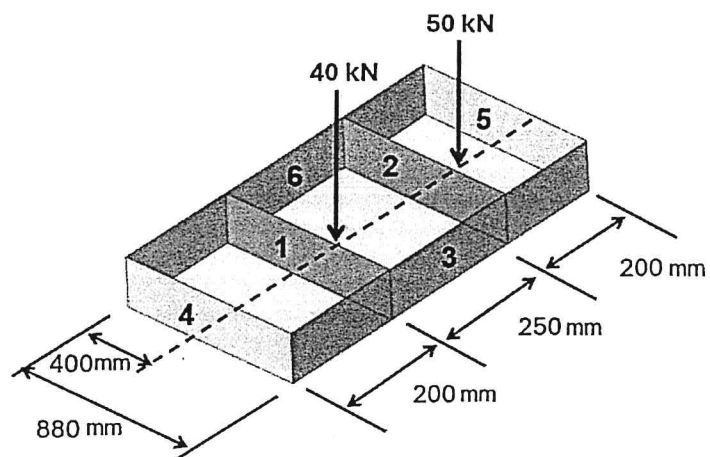


Figure 7: Simple structure surfaces of a sedan car

Question 5

Chapter 5: Crashworthiness

- (a) A Honda CRV is having a crash test that impacts a rigid barrier as in the below figure. During the impact, the car is speeding at 60km/h with average crush load of 450 kN and deceleration of 250 m/s^2 . Calculate:

Refer Below - Figure8 : Crash test .

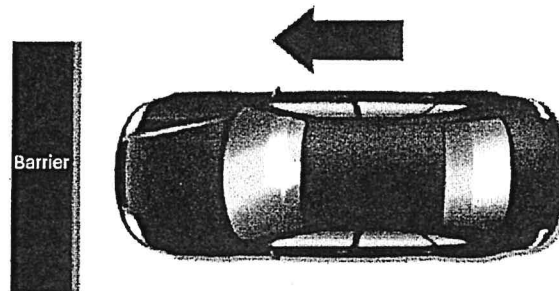


Figure 8: Crash test

- i. The mass of the car. (3 marks)
- ii. Crash time. (3 marks)
- iii. Deformation distance. (4 marks)
- (b) During a crash test, a Nissan Almera is speeding at 55 km/h and impacts a rigid barrier. It is known that the car mass is 1300kg and it has an efficiency of about 65% in converting kinetic energy to plastic deformation during a crash, and the allowable maximum deceleration is 19G. Determine:
- Refer Below - Figure9 : Crash test of Nissan Almera .*

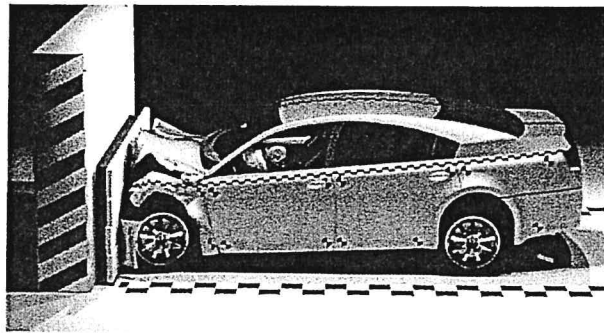


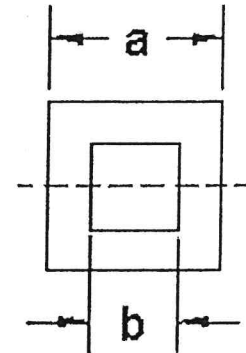
Figure 9: Crash test of Nissan Almera

- i. Average crush load. (3 marks)
- ii. Crash time. (4 marks)
- iii. Crash deformation distance. (4 marks)
- iv. The required crush space length of a passenger vehicle during a crash. (4 marks)

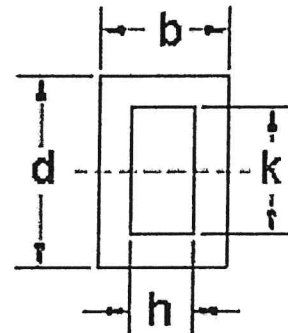
END OF EXAMINATION PAPER

APPENDIX

Description	Equation
Area Moment of Inertia Section Properties = I	$\frac{a^4 - b^4}{12}$
Section Modulus = $Z = I/y$	$\frac{a^4 - b^4}{6a}$
Radius of Gyration	$\sqrt{\frac{a^2 + b^2}{12}}$
A = area	$A = a^2 - b^2$
y = distance from axis to extreme fiber	$y = \frac{a}{2}$



Description	Equation
Area Moment of Inertia Section Properties = I	$\frac{bd^3 - hk^3}{12}$
Section Modulus = $Z = I/y$	$\frac{bd^3 - hk^3}{6d}$
Radius of Gyration	$\sqrt{\frac{bd^3 - hk^3}{12(db - hk)}}$
A = area	$A = db - hk$
y = Distance to neutral axis	$y = d/2$



$$\sigma = \frac{P}{A}$$

$$\sigma = E\epsilon$$

$$\sigma_{\max} = \frac{Mc}{I}$$

$$\phi = \frac{TL}{JG}$$

$$J = \frac{\pi}{2}c^4$$

$$\tau_{\text{avg}} = \frac{V}{A}$$

$$\delta = \frac{PL}{AE}$$

$$\tau_{\text{avg}} = \frac{T}{2tA_m}$$

$$\tau_{\max} = \frac{Tc}{J}$$

$$\epsilon = \frac{\Delta l}{l}$$

$$J = \frac{\pi}{2}(c_o^4 - c_i^4)$$

$$v = v_0 + a_c t$$

$$x = x_0 + v_0 t + \frac{1}{2} a_c t^2$$

$$v^2 = v_0^2 + 2a_c (s - s_0)$$

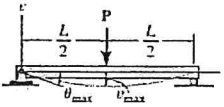
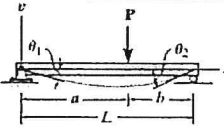
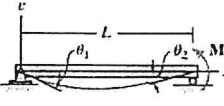
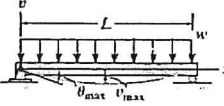
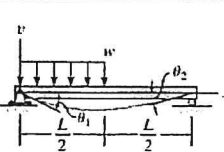
$$\frac{1}{2} M V_0^2 = F_{\text{AVG}} \Delta$$

$$\eta = \frac{F_{\text{AVG}}}{F_{\text{MAX}}} \quad (0 < \eta < 1)$$

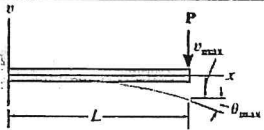
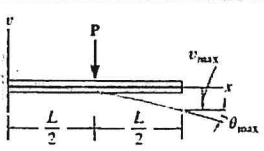
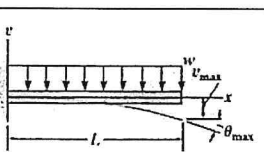
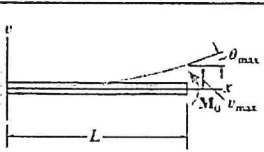
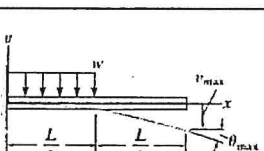
$$\sigma_{\text{avg}} = \frac{\sigma_x + \sigma_y}{2}$$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Simply Supported Beam Slopes and Deflections

Beam	Slope	Deflection	Elastic Curve
	$\theta_{\max} = \frac{-PL^2}{16EI}$	$v_{\max} = \frac{-PL^3}{48EI}$	$v = \frac{-Px}{48EI}(3L^2 - 4x^2)$ $0 \leq x \leq L/2$
	$\theta_1 = \frac{-Pab(L+b)}{6EIL}$ $\theta_2 = \frac{Pab(L+a)}{6EIL}$	$v \Big _{x=a} = \frac{-Pba}{6EIL}(L^2 - b^2 - a^2)$	$v = \frac{-Pbx}{6EIL}(L^2 - b^2 - x^2)$ $0 \leq x \leq a$
	$\theta_1 = \frac{-M_0L}{6EI}$ $\theta_2 = \frac{M_0L}{3EI}$	$v_{\max} = \frac{-M_0L^2}{\sqrt{243}EI}$ at $x = 0.5774L$	$v = \frac{-M_0x}{6EIL}(L^2 - x^2)$
	$\theta_{\max} = \frac{-wL^3}{24EI}$	$v_{\max} = \frac{-5wL^4}{384EI}$	$v = \frac{-wx}{24EI}(x^3 - 2Lx^2 + L^3)$
	$\theta_1 = \frac{-3wL^3}{128EI}$ $\theta_2 = \frac{7wL^3}{384EI}$	$v \Big _{x=L/2} = \frac{-5wL^4}{768EI}$ $v_{\max} = -0.006563 \frac{wL^4}{EI}$ at $x = 0.4598L$	$v = \frac{-wx}{384EI}(16x^3 - 24Lx^2 + 9L^3)$ $0 \leq x \leq L/2$ $v = \frac{-wL}{384EI}(8x^3 - 24Lx^2 + 17L^2x - L^3)$ $L/2 \leq x < L$

Cantilevered Beam Slopes and Deflections

Beam	Slope	Deflection	Elastic Curve
	$\theta_{\max} = \frac{-PL^2}{2EI}$	$v_{\max} = \frac{-PL^3}{3EI}$	$v = \frac{-Px^2}{6EI}(3L - x)$
	$\theta_{\max} = \frac{-PL^2}{8EI}$	$v_{\max} = \frac{-5PL^3}{48EI}$	$v = \frac{-Px^2}{6EI}\left(\frac{3}{2}L - x\right) \quad 0 \leq x \leq L/2$ $v = \frac{-PL^2}{24EI}\left(3x - \frac{1}{2}L\right) \quad L/2 \leq x \leq L$
	$\theta_{\max} = \frac{-wL^3}{6EI}$	$v_{\max} = \frac{-wL^4}{8EI}$	$v = \frac{-wx^2}{24EI}(x^2 - 4Lx + 6L^2)$
	$\theta_{\max} = \frac{M_0L}{EI}$	$v_{\max} = \frac{M_0L^2}{2EI}$	$v = \frac{M_0x^2}{2EI}$
	$\theta_{\max} = \frac{-wL^3}{48EI}$	$v_{\max} = \frac{-7wL^4}{384EI}$	$v = \frac{-wx^2}{24EI}\left(x^2 - 2Lx + \frac{3}{2}L^2\right) \quad 0 \leq x \leq L/2$ $v = \frac{-wL^3}{192EI}\left(4x - L/2\right) \quad L/2 \leq x \leq L$

