TEACHING PLAN
BUILDING ENGINEERING VOCATIONAL EDUCATION (BEVE) STUDY PROGRAM
CIVIL ENGINEERING DEPARTMENT, FACULTY OF ENGINEERING, UNIVERSITAS NEGERI PADANG

COURSE	CODE	COURSE CLUSTER	CREDITS		SEM	VERSION
			Theory	Practice		
STRUCTURAL ANALYSIS	SIP1.61.5302		1	2	5	1

Lecturer in Charge		Lecturer in Charge
	Dr. Eng. Prima Yane Putri, ST, MT **Prima Zola, ST, MT** **Annisa Prita Melinda, ST, MT**	

Remarks	Dean of Faculty of Engineering	Head of Civil Engineering Department	Coordinator of BEVE
	Dr. Fahmi Rizal, M.Pd., M.T NIP. 195912041985031004	Faisal Ashar, Ph.D. NIP. 19750103 200312 1001	Drs. Revian Body, MSA. NIP. 19600103 198503 1003

Program Learning Outcomes	Program Learning Outcomes (PLO)
	1. The ability to apply basic knowledge of science (math, nature science) and other multidisciplinary knowledge as the basic of *Building Engineering Vocational Education* in carrying out its professional work *(Knowledge and Understanding).* 1.1. Able to show the good understanding and to implement the basic concept of math to solve various problems in building engineering field. 1.2. Having a high understanding and able to implement the basic concept of physic and Chemistry (nature science) in building engineering field. 1.3. Having deep understanding and able to implement the basic principle of engineering (mechanical, engineering drawing, mechanic of material) of building engineering.

	2. The ability to think critically and creatively in identifying, formulating, problem solving, and evaluating various problems in building engineering vocational educatipn field by using the most appropriate and effective scientific method (Engineering analysis, investigations and assessment). 2.1. Able to identify technical problem in building engineering 2.2. Able to analyse technical problems in building engineering aspect. 2.3. Able to evaluate technical problems in building engineering aspect 2.4. Able to communicate *Engineering Analysis aspects, Investigation and Assessment* to students or trainee. 3. The reliable ability to plan, implement, and supervise the works in building engineering field. (Engineering design). 3.1. Able to realise as built drawing and cooperate with other stakeholders. 3.2. Able to manage technical aspects of building as well as environmental, social, helath and safety aspects. 3.3. Able to supervise technical aspect of buildings. 3.4. Able to communicate Engineering design matters to students. 4. Having competency to design, constructs and evaluate learning processes in *Building Engineering Vocational Education (Education design).* 4.1. Able to design curriculum and learning process in building engineering. 4.2. Able to conduct, control, evaluate and improve the quality of learning process. 4.3. Able to develop learning media effectively, efficiently and interesting. 5. The ability to adapt and innovate towards science and technology development and implement it to the goal of educational and professional work by considering the risk of non-technical aspect that might be happened. *(Engineering practice).* 5.1. Able to innovate and develop technology in building engineering by considering social, economy and environmental aspects. 5.2. Able to analyse environmental condition in design, construction and supervision process of building.

5.3. Implementing information technology and computer into design, construction and supervision process of building.

6. Having social and managerial competencies, cooperate, communicate effectively, entrepreneurial character, environmentally knowledgeable, and awareness of longlife learning. *(Transferable and softskill).*
   6.1. Able to work creatively, innovatively, collaboratively, carefully, responsibly, and responsive to environmental change.
   6.2. Have curiosity and critical thinking, open-minded, and objective.
   6.3. Able to communicate effectively, and to collaborate in a team work.

Course Learning Outcomes

Course Learning Outcomes (CLO):

CLO	CPL
1. Explain the type of structural systems and structural analysis concept.	1.1, 1.2, 1.3
2. Explain the basic of software usage of structural analysis (SAP2000 versi student)	1.3
3. Analyze continues beam structure	1.3, 2.1, 2.2, 2.3, 2.4
4. Analyze 2D Frame structure.	1.3, 2.1, 2.2, 2.3, 2.4
5. Analyze and design 3D Frame structure.	1.3, 2.1, 2.2, 2.3, 2.4
6. Analyze 2D truss.	1.3, 2.1, 2.2, 2.3, 2.4
7. Analyze and design 3D truss structure.	1.3, 2.1, 2.2, 2.3, 2.4
8. Understand and explain earthquake definition, earthquake types and earthquake occurences.	2.1
9. Understand and explain risk level of earthquake in Indonesia, earthquake parameters and its effects to the building.	2.1, 2.2
10. Understand the basic of design and construction of earthquake resistant housing (minimum requirement of earthquake safer housing) and the repairing method of damaged building.	2.3, 2.4, 3.2, 3.3, 3.4
11. Analyse and design the structures towards earthquake load by using Static Equivalent Method.	5.1, 5.2

	12. Design structural system based on any laod combination. — 5.3, 6.1, 6.2, 6.3
Course Description	Structural analysis course is application of static, engineering mechanic, steel structure and concrete structure courses. In this course, student can analyse and design structures by applying structural analysis basic of concepts and structural analysis software (SAP2000 student version). In this subject, students have knowledge about earthquake, earthquake occurences, earthquake in Indonesia and the effect of earthquake to building.
Literature	**Main:** 1. Iman Satyarno dkk, 2012, Belajar SAP2000 Seri 1 Analisis Gempa, Zamil Publishing, Jogjakarta, Indonesia. 2. Iman Satyarno dkk, 2012, Belajar SAP2000 Seri 1, Zamil Publishing, Jogjakarta, Indonesia 3. Prima Yane Putri, 2007, Analisis dan Desain Struktur Rangka dengan SAP2000 versi Student, Penerbit UNP Press, Padang, Indonesia. 4. Prima Yane Putri, 2019, Analisis Struktur dan Perancangan Konstruksi Menggunakan SAP2000, Penerbit UNP Press, Padang, Indonesia. 5. Tavio & Usman Wijaya, 2019, Desain Gempa Berbasis Kinerja, Penerbit Andi, Yogyakarta, Indonesia. 6. Teddy Boen, 2016, Belajar dari Kerusakan akibat Gempa Bumi: Bangunan Tembokan Nir-Rekayasa di Indonesia, UGM Press, Yogyakarta, Indonesia. 7. Weaver Jr., W., dan Gere., J.M., 1989, Analisis Matriks Untuk Struktur Rangka, edisi kedua, Penerbit Erlangga, Jakarta, Indonesia. 8. Wiryanto Dewobroto, 2013, Komputer Rekayasa Struktur dengan SAP2000, penerbit Dapur Buku, Jakarta, Indonesia. **Supporting:** 1. Badan Standarisasi Nasional, SNI 1726:2019 Tata Cara Perencanaan Ketahanan Gempa Untuk Struktur Bangunan Gedung Dan Non Gedung, Jakarta, Indonesia. 2. Badan Standarisasi Nasional, SNI 1727:2013 Beban Minimum Untuk Perancangan Bangunan Gedung Dan Struktur Lain, Jakarta, Indonesia. 3. Badan Standarisasi Nasional, SNI 1729:2015 Spesifikasi Untuk Bangunan Gedung Baja Struktural, Jakarta, Indonesia. 4. Badan Standarisasi Nasional, SNI 2847:2019 Persyaratan Beton Struktural Untuk Bangunan Gedung dan Penjelasan, Jakarta, Indonesia. 5. Badan Standarisasi Nasional, SNI 7973:2013 Spesfikasi Desain Untuk Konstruksi Kayu, Jakarta, Indonesia.

	6. Juniman Silalahi, 2009, Mekanika Struktur Jilid I, UNP Press, Padang, Indonesia. 7. Juniman Silalahi, 2014, Struktur Beton untuk Bangunan Gedung, UNP Press, Padang, Indonesia. 8. Nasution, Amrinsyah, 2002, Analisis Struktur dengan Metode Matrik Kekakuan, Penerbit ITB, Bandung, Indonesia. 9. Ngudi Hari Crista, 2018, Belajar Mandiri Mebuat Struktur Rumah Dua Lantai dengan SAP2000, 2018, Penerbit Andi, Yogyakarta, Indonesia. 10. Purbolaras Nawangalam, 2019, Desain Struktur Bangunan, Wahana Resolusi, Yogyakarta, Indonesia 11. Wiryanto Dewobroto, 2016, Struktur Baja: Perilaku, Analisis & Desain – AISC 2010, Penerbit Jurusan Teknik Sipil UPH, Tangerang, Indonesia.	
Teaching Media	**Software: SAP2000**	**Hardware:**
		Computer, LCD Projector, whiteboard set.
Team Teaching		
Assessment	Mid, final exam, individual and group assignments.	
Prerequisite	Static, engineering mechanic, steel structure and concrete structure.	

MATERI PEMBELAJARAN

Week	Expected Competency	Study Material	Teaching Method and Strategy	Assignment	Assessment Criteria/ Indicator	Reference
(1)	**CPMK-1: [CPL-1.1, 1.2, 1.3)** Ability to understand the type of structural system and the basic of structural analysis concept.	Type of structural system and structural analysis basic concept.	lesson explanation **[1x50']** QA **[1x20']** Review **[1x120']** Discussion **[1x60']**	Conclude and describe the lesson in resume book	Able to understand the type of structural system and the basic of structural analysis concept.	RU-3, RU-4, RU-7, RU-8, RP-6, RP-8
(2)	**CPMK-2: [CPL-1.3]** Ability to understand and master the basic of structural anlaysis software (SAP2000 versi student)	the basic of structural anlaysis software (SAP2000 versi student)	lesson explanation **[1x50']** Review **[1x120']** Discussion **[1x60']** Home work **[1x180']**	• Conclude and describe the lesson in resume book • Practice in utilizing SAP 2000 software.	Able to understand and master the basic of structural anlaysis software (SAP2000 versi student)	RU-3, RU-4, RU-8

Week	Expected Competency	Study Material	Teaching Method and Strategy	Assignment	Assessment Criteria/ Indicator	Reference
(3)	**CPMK-3: [CPL-1.3, 2.1, 2.2, 2.3, 2.4]** Able to understand and analyze continues beam structure.	Analysis of continiues beam structure	Explanation **[1x50']** QA **[1x20']** Homework**[1x180']**	• Conclude and describe the lesson in resume book • Practice in utilizing SAP 2000 software	Able to understand and analyze continiues beam structure	RU-1, RU-2, RU-3, RU-4, RU-8
(4)	**CPMK-4: [CPL-1.3, 2.1, 2.2, 2.3, 2.4]** Ability to understand and analyze 2D Frame	Analysis of 2D frame	Explanation **[1x50']** QA **[1x20']** Homework**[1x180']**	• Conclude and describe the lesson in resume book • Practice in utilizing SAP 2000 software	Able to understand and analyze 2D Frame	RU-1, RU-2, RU-3, RU-4, RU-8, RP-2, Rp-4
(5)	**CPMK-5: [CPL-1.3, 2.1, 2.2, 2.3, 2.4]** Able to understand and analyze and designing 3D Frame	Analysis of 3D frame	Explanation **[1x50']** QA **[1x20']** Homework**[1x180'**	• Conclude and describe the lesson in resume book • Practice in utilizing SAP 2000 software	Able to understand and analyze and designing 3D Frame	RU-1, RU-2, RU-3, RU-4, RU-8, RP-7, RP-9
(6)	**CPMK-6: [CPL-1.3, 2.1, 2.2, 2.3, 2.4]** Ability to understand and analyze 2D Truss structure.	Analysis of 2D Truss	Explanation **[1x50']** QA **[1x20']** Home work**[1x180'**	• Conclude and describe the lesson in resume book • Practice in utilizing SAP 2000 software	Able to understand and analyze 2D Truss	RU-1, RU-2, RU-3, RU-4, RU-8, RP-7, RP-9
(7)	**CPMK-7: [CPL-1.3, 2.1, 2.2, 2.3, 2.4** Able to understand and analyze 3D Truss	Analysis of 3D Truss	Explanation **[1x50']** QA **[1x20']** Homework**[1x180'**	• Conclude and describe the lesson in resume book • Practice in utilizing SAP 2000 software	Able to understand and analyze 3D Truss	RU-1, RU-2, RU-3, RU-4, RU-8, RP-2, RP-3, RP-5, RP-11
(8)	**Mid term evaluation**					

Week	Expected Competency	Study Material	Teaching Method and Strategy	Assignment	Assessment Criteria/ Indicator	Reference
(9)	**CPMK-8: [CPL-2.1]** Able to understand and explain the defenition, type and the occurence of the earthquake.	the defenition, type and the occurence of the earthquake	Explanation **[1x100']** QA **[1x20']** Homework **[1x130']**	• Conclude and describe the lesson in resume book • Homework	Able to understand and explain the defenition, type and the occurence of the earthquake	RU-5, RU-6, RP-1
(10)	**CPMK-9: [CPL-2.1, 2.2]** Able to understand and explain the level of earthquake risk in Indonesia, earthquake parameter and measurement and its effect to the building.	the level of earthquake risk in Indonesia, earthquake parameter and measurement and its effect to the building.	Explanation **[1x100']** QA **[1x20']** Homework **[1x130']**	• Conclude and describe the lesson in resume book • Homework	Able to understand and explain the level of earthquake risk in Indonesia, earthquake parameter and measurement and its effect to the building	RU-5, RU-6, RP-1
(11)	**CPMK-10: [CPL-2.3, 2.4, 3.2, 3.3, 3.4]** Able to undertand the basic concept of design and construction of earthquake resistant housing (minimum requirement of safer housing)	design and construction of earthquake resistant housing (minimum requirement of safer housing)	Explanation **[1x100']** QA **[1x20']** Homework **[1x130']**	• Conclude and describe the lesson in resume book • Homework	Able to undertand the basic concept of design and construction of earthquake resistant housing (minimum requirement of safer housing)	RU-5, RU-6, RP-1, RP-2, RP-4
(12)	**CPMK-10: [CPL-2.3, 2.4, 3.2, 3.3, 3.4]** Able to understand and explain the repairing method for damaged building	repairing method for damaged building	Explanation **[1x100']** QA **[1x20']** Homework **[1x130']**	• Conclude and describe the lesson in resume book • Homework	Able to understand and explain the repairing method for damaged building	RU-6

Week	Expected Competency	Study Material	Teaching Method and Strategy	Assignment	Assessment Criteria/ Indicator	Reference
(13)	**CPMK-11: [CPL-5.1, 5.2]** Able to understand earthquake cooffecient, Identification factor, Structural type cooffecient, natural time period, shear load division along building height.	earthquake cooffecient, Identification factore, Structural type cooffecient, natural time period, shear load division along building height.	Explanation **[1x100']** QA **[1x20']** Homework **[1x130']**	• Conclude and describe the lesson in resume book • Homework	Able to understand earthquake cooffecient, Identification factore, Structural type cooffecient, natural time period, shear load division along building height	RU-5, RP-1, RP-2, RP-4
(14)	**CPMK-11: [CPL-5.1, 5.2]** Able to analyze and design structure subjected to earthquake load by using Equivalent Static Method.	analyze and design structure subjected to earthquake load by using Equivalent Static Method.	Explanation **[1x50']** QA **[1x20']** Homework **[1x180']**	• Conclude and describe the lesson in resume book • Homework	Able to analyze and design structure subjected to earthquake load by using Equivalent Static Method.	RU-5, RP-1, RP-2, RP-4
(15)	**CPMK-12: [CPL-5.3, 6.1, 6.2, 6.3]** Able to design many structural system subjected any loading combinations.	design many structural system subjected any loading combinations	Explanation **[1x50']** QA **[1x20']** Homework **[1x180']**	• Conclude and describe the lesson in resume book • Homework	Able to design many structural system subjected any loading combinations	RU-1, RU-2, RU-3, RU-4, RU-8, RP-1, RP-2, RP-3, RP-4, RP-7, RP-9, RP-10, RP-11
(16)	**Final Exam**					

Notes :

1 sks = (50' TM + 60' BT + 60' BM)/Week
TM = Class (Kuliah)
BT = Structured Lesson.
BM = Individual lesson
PL = Laboratory lesson (200 minute/week)
T = Theory (Knowledge aspect)
P = Practice (Skill aspect)

Correlation between CLO, PLO and Assessment Method

	Assesment	Score (%)	CPL-1			CPL-2				CPL-3				CPL-4			CPL-5			CPL-6		
			1	2	3	1	2	3	4	1	2	3	4	1	2	3	1	2	3	1	2	3
CPMK-1	Mid.1	10	√	√	√																	
CPMK-2	Mid.1				√																	
CPMK-3	Mid.2	5			√	√	√	√	√													
CPMK-4	Mid.3	5			√	√	√	√	√													
CPMK-5	Mid.4	10			√	√	√	√	√													
CPMK-6	Assignment1	15			√	√	√	√	√													
CPMK-7					√	√	√	√	√													
CPMK-8	Assignment 2.1	10				√																
CPMK-9	Assignment 2.1					√	√															
CPMK-10	Assignment 2.2, Assignment 2.3	7.5, 7.5						√	√		√	√	√									
CPMK-11	Final.1,Final.2	5, 15															√	√				
CPMK-12	Final.3	10																	√	√	√	√
TOTAL		100																				

Assesment Components

Mid Semester : 30 %

Final Exam : 30 %

Assignment 1 : 15 %

Assignment 2 : 25 %

Presence : (greater than 80%)

Total : 100 %

Description of Assessment Level

	Excellent	**Good**	**Satisfy**	**Fail**
Description	Able to describe correctly and complete.	Able to describe correctly and uncomplete.	Able to describe nor correctly and uncomplete.	Unable to describe
Formulation	Able to formulate correctly and complete	Able to formulate correctly and uncomplete	Able to formulate nor correctly and uncomplete.	Unable to formulate
Calculation	Able to calculate correctly and complete.	Able to calculate correctly and ucomplete.	Able to calculate nor correctly and uncomplete.	Unable to calculate
Analysis	Able to analyze correctly and complete.	Able to analyze correctly and uncomplete.	Able to analysis nor correctly and uncomplete.	Unable to analyze

Sistem Penilaian

Score Range	Grade Letter	Grade Point	Notes	Score Range	Grade Letter	Grade Point	Notes
85 – 100	A	4.0	Exceptional	55 – 59	C	2.0	Quite Satisfactory
80 – 84	A-	3.6	Excellent	50 – 54	C-	1.6	Poor
75 – 79	B+	3.3	Very Good	40 – 49	D	1.0	Very Poor
70 – 74	B	3.0	Good	≤ 39	E	0.0	Fail
65 – 69	B-	2.6	Fairly Good	-	T	-	Delayed
60 – 64	C+	2.3	Satisfactory				

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MIDTERM EXAM

Course	: Structural Analysis
Code/Credits	: SIP1.61.5302 / 3
Type of Exam	: Open Book
Dosen	: Dr. Eng. Prima Yane Putri, ST, MT
Time Allocation	: 120 minutes
Maximum grade	: 30

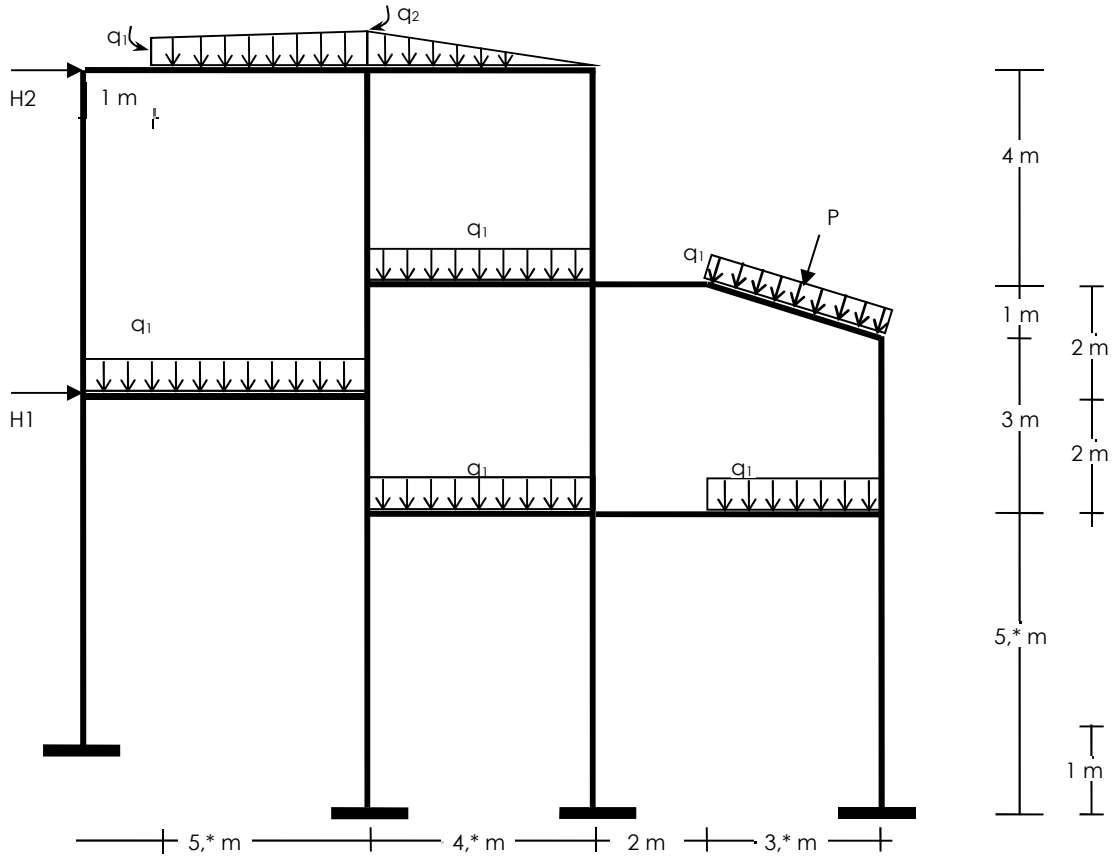
A reinforced concrete structural frame is known as follow

Section properties : structural column dimension : 40 cm, Beam dimension : 30/45 cm

Material Properties :

- Reinforcement spec. f_y = 400 MPa, stirrup spec f_y = 240 MPa, dan concrete f_c' = (20+*) MPa.
- Concrete poisson : υ = 0.20, concrete weight : γ_c = 2400 kg/m^3
- Use reduction factor for concrete as SNI Beton 2019 ∅Momen = 0.8, ∅tension = 0.65, ∅shear = 0.6, ∅compression = 0.7

Structural model :



Structural loading :

1. Dead load (DL) : distributed load, q_1 = 2,* ton/m, trapezium and triangle load , q_1 = 2,* ton/m and q_2 = 4,* ton/m.
2. Live load (LL) : Point load P = 3 ton
3. Earthquake load (EQ) : H1 = 2,* ton, H2 = 4,* ton

Note : * last number of your NIM, ex NIM 12345, * = 5

Question :

1. *(Score: 10)* Draw the structural model in SAP200
2. *(Score: 5)* Calculate the stress in structural elements (flexural, shear, normal), deformation, restraint reaction considering the selfweight of structure, based on followed loading combination :
    1. Fix Loading : U = 1,2 DL + 1,6 LL
    2. Temporary Loading 1 : U = 1,2 DL + 0,5 LL + 1,1 EQ
    3. Temporary Loading 2 : U = 1,2 DL + 0,5 LL - 1,1 EQ
3. *(Score: 5)* Show load for every loading case and minimum reinforcement section area diagram that needed by the structure.
4. *(Score: 10)* Show your design results on the following table:

No	Type elemen	Section dimension	Section area and reinforcement detailing Drawing
1.	Beam 1st storey		
2.	Beam 2nd storey		
3.	Column 1st storey		
4.	Column 2nd storey		
5.	etc...		

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FINAL EXAM
MIDTERM

Course : Structural Analysis
Code / Credits : SIP1.61.5302 / 3
Type of Exam : Open Book
Lecturer : Dr. Eng. Prima Yane Putri, ST, MT
Time Allocation : 250 minutes
Maximum grade : 30

Find a lay out of a building with minimum 2 storey. The building can be functioned as any (ruko, office, etc).

From that drawing, please:

1. *(Score: 5)* Design the building's structural element (column and beam) by using preliminary design step as you learnt in concrete structure subject.
2. *(Score: 15)* Calculate the loading (dead load, live load and static earthquake loading) which happened in strctures and do analysis of structure by using SAP2000 program with loading combination based on SNI 1727:2013.
3. *(Score: 10)* Design 3D frame structure of the building and show the design results on this following table.

No	Type elemen	Dimension	Design moment	Section area and reinforcement detailing Drawing
1.	Beam 1st storey			
2.	Beam 2nd storey			
3.	Column 1st storey			
4.	Column 2nd storey			
...etc	*(if you want to be detailed)*			

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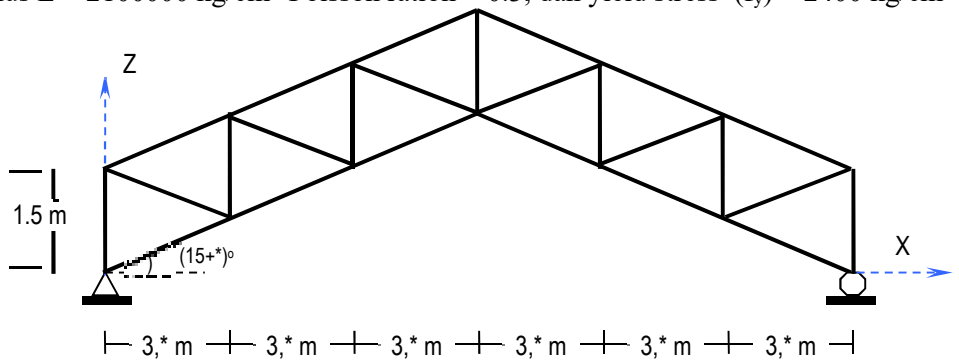
ASSIGNMENT 1

Course	: Structural Analysis
Code / Credits	: SIP1.61.5302 / 3
Type of Assignment	: Individual assignment
Lecturer	: Dr. Eng. Prima Yane Putri, ST, MT
Time Allocation	: 1 minggu
Score	: 30

A building with steel roof structure located in mountainous area, has configuration as below picture. The span of roof truss = = (6 X 3,*) m, truss = (10+*)^o and the distance between the truss element is (B) = 4 m.

The roof cover uses clay tile with reng and usuk and plafond. Steel's spesific weight is 7850 kg/m^3, dan Steel young's modulus E = 2100000 kg/cm$^{2.}$ Poisson ration = 0.3, dan yield stress (f_y) = 2400 kg/cm^2 (BJ-37).



Note : * last number of your NIM, ex NIM 12345, * = 5

For your preliminary design, top chord and bottom chord, both are using individual angle profile DIN 24. Vertical element and diagonal use DIN 28. Profil I data known as follow :

Profil I	Height(mm)	widht (mm)	thickness (mm)	Wing thickness (mm)
DIN – 24	240	240	11	18
DIN – 28	280	280	12	20

Assumed structure selfweight is negleted, calculate:

1. *(Score: 5)* Loading at structures
2. *(Score: 5)* Reaction at supports, member's forces and deformation. Analyze the above strcture for 3 load combinations :
   1. Fix loading (COMB 1) : Dead load + Live Load
   2. Temporary load (COMB 2) : Dead Load + Live Load + Wind Load (right)
   3. Temporary load (COMB 3) : Dead Load + Live Load + Wind Load (left)

3. *(Score: 5)* Show stress ratio diagram happened in structure. From that stress ratio diagram, show your opinion wether the profil specification is enouh or not. (Print: structural model drawing and frame section, loading per case and stress ratio diagram)

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ASSIGNMENT 2

Course	: Structural Analysis
Code / credits	: SIP1.61.5302 / 3
Type of Assignment	: Individual assignment
Lecturer	: Dr. Eng. Prima Yane Putri, ST, MT
Time	: 1 month
Score	: 25

No	Assigment	Score
1.	Observe buildings in your environment, which constructed post 30th September 2009 earthquake. Analyze that building regard to the fullfillment of Minimum requirement of safer housing. (at least 5 houses).	10
2.	Find a building (simple house or multistorey building/office) which is damaged by earthquake. Analyze which repairing method suitable for that building.	7.5
3.	Find an existing design of building or make a 4 storey building. Assume by your self the building's data. Calculate earthquake forces subjecte dto each frame (X and Y direction) by using static equivalent method (adjust the results with earthquake standard in Indonesia)	7.5