# Curriculum Development Using Graphs of Learning Outcomes

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# Background

- Curriculum development project at the Department of Civil and Structural Engineering
- Supporting software
- Students: study planning
- Staff: curriculum development
- Show how courses contribute to professional competences



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### Learning outcomes are identified

Course			Outcome	cr
Rak-54.1100	Statics	1	Knows statics' basic quantities, fundamental laws and basic models	0.2
		2	Understands equivalence of force systems and knows principles of force system reduction	0.4
		3	Knows principles of equilibrium of a particle and rigid body	0.6
		4	Knows how to apply particle and equilibrium of a rigid body to determine forces for basic stuctures and mechanisms and problems with friction	1.2
		5	Knows principles of rigid body kinematics, virtual work and potellial energy	0.2
		6	Knows how to apply principles of virtual work and poteltial energy to study equilibrium of a rigid body	0.4



## Prerequisite matrix is constructed

Prerequisi Rak-54.1100

load-bea	aring		Rak-43.1215 Introduction to the design of					
		struct	tures					
1	2	3	4	5	6	7	8	
understanding of the base function of star-bases and building on an discretion of star-base function of star-bases and building on an discretion star-bases and building on a	Appreciates the significance of the difference between ducille and brittle materials for structural design and reliability measurement	gives the proficiency for dimensioning beams and columns and betwinning safety against overturning	in overall understanding of the technical content of structural dimensioning	Understanding of the diffence between limit taste dimensioning and total safety factoprapproach	Undestanding of the influence of tensioning for load bearing and tunctioning of joints	knowing of the types and magnitudes of ordinary loadings of structures	Recognition of different support systems of buildings and their connection to the purpose of use of building	
te course Outcome cr								
Statics 1 Knows statics' basic quantities, fundamental laws and basic models 0.2 V		v			v		v	
2 Understands equivalence of force systems and knows principles of force system reduction 0.4 v		v					v	
3 Knows principles of equilibrium of a particle and rigid body 0.6 V		v					v	
4 Knows how to apply particle and equilibrium of a rigid body to determine forces for basic stuctures and mechanisms and problems with friction 1.2 V		v			т			
5 Knows principles of rigid body kinematics, virtual work and poteltial energy 0.2 T				v			v	
6 Knows how to apply principles of virtual work and poteltial energy to study equilibrium of a rigid body 0.4 T				т				

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### Outcomes are grouped into professional competences



### Student chooses competences

#### Competences

Structural Engineering - Bridges and other Infrastructural Constructions	
Level I	Designing parts of small bridges. Junior brige designer. (CC1, EN 1990).
Level II	Designing small and medium bridges and parts of large bridges. Bridge designer. (CC2, EN 1990).
Level III	Designing large bridges. (CC3, EN 1990).

<u>Structural Engineering - Timber</u> <u>Structures</u>						
Level I	Small one storey wooden buildings. Class C qualification.					
Level II	At most two storey wooden buildings, less than 15 m spanning structures.					
Level III	Over two storey wooden buildings, over 15 m spanning structures.					

Building Physics - Heat and Moisture Engineering	
Level I	Tavanomaisten, vaatimukseltaan helppojen, kuten varastorakennusten lämpö- ja kosteustekninen suunnittelu. Ratkaisujen valinta suunnitteluohjeiden perusteella. B-class qualification.
Level II	Tavanomaisten rakennusten, kuten asuu ja liikerakennusten lämpö- ja kosteustekninen suunnittelu. Rakenneratkaisujen valinnassa korostuu kokonaisuuden hallinta käyttäen rakenteita joiden toiminta tunnetaan A-Ciase qualification.
Level III	Vaativen kohteiden, kuten jäähallien, uimahallien ja prosessteollisuuden rakennuksien lämpö- ja kosteustekninen suunnittelu. Iisäksi rakenneratkaisujen tuotekehitystelitävät ja analyysipohjainen suunnittelu. Ak-člass qualification.

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### Set of courses is calculated

#### Structural Engineering - Bridges and other Infrastructural Constructions

Level I			+ Add to plan
Designing parts of small bridges. Junior brige designer. (CC1,	EN 1990).		
Provides	Mandatory	prerequisites	
<ul> <li>Provides</li> <li>Recognizes the different types of bridges, bridge parts and details.</li> <li>Understands the loads on bridges and foundations.</li> <li>Understands the loads on bridge and foundations.</li> <li>Knows the different foundation types.</li> <li>Understands the principles and tools for data and product modelling.</li> <li>Knows the basics of bridge drawings and modeling.</li> <li>Can calculate stress resultants and governing load combinations</li> <li>Knows how to design foundation structures.</li> </ul>	Táy-si,1181 Táy-si,1181 Rak-53,121 Rak-54,1300 Táy-si,182 Rak-54,1300 Mat-1,132 Mat-1,1420 Mat-1,1420 Mat-1,1420 Mat-1,1322 KR-55,2200 Mat-1,1322 KR-55,2200 Mat-1,1227 Rak-54,1200 Mat-1,1227 Rak-54,1200 Mat-1,127 Rak-54,1200 Mat-1,127 Rak-54,1200 Mat-1,127 Rak-54,1200 Mat-1,127 Rak-54,1200 Mat-1,127 Rak-54,1200 Mat-1,127 Rak-54,1200 Rak-54,1200 Rak-54	prerequisites Typ-3.181 Typ-3.181 Typ-3.182 Typ-3.182 Structures Structu	3.0 5.0 0.0 4.0 5.0 1.2 3.4 3.4 3.4 3.4 3.4 5.0 1.2 1.2 3.4 3.4 5.0 1.2 1.2 3.4 3.4 3.4 5.0 1.2 1.2 3.4 3.4 5.0 1.2 1.2 3.4 5.0 1.2 1.2 3.4 5.0 1.2 1.2 3.4 5.0 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2
		Total Included in other competences Already passed	72.6 cr 0 cr 0 cr

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### Rak-54.1100 Statics

	Rak-54.1300 Introduction to Structural Mechanics: Recognises principles of statially indeterminate structures. Can apply force method and finite element method in connection with simple bar structures (trusses, beams and frames)			k-11.2107 Bridges and Foundation uctures: Understands the behaviour the most general bridge types and ows the analysing methods of them.	·	Knows how to design foundation structures.
Knows statics' basic quantities, fundamental laws and basic models	Rak-54.1300 Introduction to Structural Mechanics: Recognises principles of statially indeterminate structures. Can apply force method and finte element			Rak-11.2107 Bridges and Foundation Structures: Understands the dimensioning principles of pile		Understands the principles and tools for data and
Understands equivalence of force systems and knows principles of force system	method in connection with simple bar structure (trusses, beams and frames)	S	for for	ndations and can determinate the ces in piles.		product modelling.
reduction Knows principles of equilibrium of a particle and	Rak-54.1200 Mechanics of Materials for Structures: Recognises 3-dimensinal state of strain and Hooke's law	Rak-11. Structur bridges,	2107 res: l brid	7 Bridges and Foundation Recognizes the different types of lge parts and details.	•	Recognizes the different types of bridges, bridge parts and details.
rigid body Knows how to apply particle	Rak-54.1300 Introduction to Structural Mechanics:			Rak-11.2107 Bridges and		Can calculate stress
and equilibrium of a rigid body to determine forces for basic stuctures and	Can apply force method and finte element method in for connection with simple bar structures (trusses, beams a)		). 1	Understands the the design principles of the most genera bridge types.	۲	resultants and governing load combinations
mechanisms and problems with friction	Rak-54.1300 Introduction to Structural Mecha	nics:		Pak-11 2107 Pridges and		
Knows principles of rigid body kinematics, virtual work and potential energy.	Recognises principles of statially indeterminate structure Can apply force method and finte element method in connection with simple bar structures (trusses, beams a		Foundation Structures: Can determine the stressresultants and		•	Understands the loads on bridges and foundations.
Knows how to apply	frames)			do simple designs.		
and poteltial energy to study equilibrium of a rigid body	Rak-54.2100 Structural Mechanics I: Has the ability to applying the theory of elasticity			critically analyze beams and frames by		Knows how to design simple bridges.
	Rak-54.1300 Introduction to Structural Mechan Recognises principles of statially indeterminate Can apply force method and finte element meth connection with simple bar structures (trusses, frames)	nics: structures iod in beams and	s. 1	Rak-11.2107 Bridges and Foundation Structures: Understands the the design principles of the most genera bridge types.	•	Understands the the design principles of the most common bridge types.

### Rak-54.1100 Statics

	Rak-54.1300 Introduction to Structural Mechan Recognises principles of statially indeterminate structures. Can apply force method and finte ele method in connection with simple bar structures (trusses, beams and frames)	iics: ement 🕨	Rak-11.2107 Bridges and Foundation Structures: Understands the behaviour of the most general bridge types and knows the analysing methods of them.	Knows how to design foundation structures.
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Understands equivalence of force systems and knows principles of force system	method in connection with simple bar structures (trusses, beams and frames)	5	foundations and can determinate the forces in piles.	product modelling.
reduction Knows principles of	Rak-54.1200 Mechanics of Materials for Structures: Recognises 3-dimensinal state of	Rak-11. Structur	2107 Bridges and Foundation res: Recognizes the different types of	Recognizes the different types of bridges, bridge
equilibrium of a particle and rigid body	strain and Hooke's law	bridges,	bridge parts and details.	parts and details.
Knows how to apply particle and equilibrium of a rigid body to determine forces for basic stuctures and mechanisms and problems	Recognises principles of statially indeterminate - Can apply force method and finte element metho connection with simple bar structures (trusses, b frames)	structures od in peams and	<ul> <li>Foundation Structures:</li> <li>Understands the the design principles of the most genera bridge types.</li> </ul>	Can calculate stress resultants and governing load combinations
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Knows how to apply principles of virtual work and poteltial energy to study equilibrium of a rigid body	Rak-54.2100 Structural Mechanics I: Has the ab applying the theory of elasticity	pility to cr	itically analyze beams and frames by	Knows how to design simple bridges.
	Rak-54.1300 Introduction to Structural Mechan Recognises principles of statially indeterminates Can apply force method and finte element meth connection with simple bar structures (trusses, b frames)	iics: structures od in peams and	Rak-11.2107 Bridges and Foundation Structures: Understands the the design principles of the most genera bridge types.	Understands the the design principles of the most common bridge types.

### Rak-54.1100 Statics

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Knows statics' basic quantities, fundamental laws and basic models	Rak-54.1300 Introduction to Structural Mechar Recognises principles of statially indeterminate structures. Can apply force method and finte ele	Rak-11.2107 Bridges and Foundation Structures: Understands the dimensioning principles of pile		Understands the principles and tools for data and	
Understands equivalence of force systems and knows principles of force system	method in connection with simple bar structures (trusses, beams and frames)	2	foundations and can determinate forces in piles.		product modelling.
reduction	Rak-54.1200 Mechanics of Materials for Structures: Recognises 3-dimensinal state of	Rak-11. Structu	2107 Bridges and Foun res: Recognizes the diffe	Recognizes the different types of bridges, bridge	
equilibrium of a particle and rigid body	strain and Hooke's law bridges		bridge parts and detai	.s.	parts and details.
Knows how to apply particle and equilibrium of a rigid body to determine forces for basic stuctures and	Rak-54.1300 Introduction to Structural Mechar Recognises principles of statially indeterminate Can apply force method and finte element meth connection with simple bar structures (trusses, I frames)	nics: structure od in beams and	Rak-11.2107 Brid Foundation Struct Understands the t principles of the n bridge types.	Can calculate stress resultants and governing load combinations	
with friction	Rak-54.1300 Introduction to Structural Mecha	nics:	Rak-11.2107 Bri	dges and	
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Knows how to apply	frames)		and do simple de	signs.	
and poteltial energy to study equilibrium of a rigid body	Rak-54.2100 Structural Mechanics I: Has the ability to critically analyze beams and frames by applying the theory of elasticity				Knows how to design simple bridges.
	Rak-54.1300 Introduction to Structural Mechar Recognises principles of statially indeterminate Can apply force method and finte element meth connection with simple bar structures (trusses, frames)	nics: structure od in beams and	Rak-11.2107 Brid Foundation Struc Understands the t principles of the n bridge types.	ges and tures: he design nost genera	Understands the the design principles of the most common bridge types.

### Rak-54.1100 Statics

	Rak-54.1300 Introduction to Structural Mechanics: Recognises principles of statially indeterminate			ak-11.2107 Br. tructures: Und	ridges and Foundation lerstands the behaviour		Knows how to design
	structures. Can apply force method and finite element method in connection with simple bar structures (trueses, became and farmes)			f the most gene nows the analy	eral bridge types and /sing methods of them.		foundation structures.
Knows statics' basic	Rak-54.1300 Introduction to Structural Mechan	nics:	R	ak-11.2107 Br	idges and Foundation		
quantities, fundamental laws and basic models	Recognises principles of statially indeterminate structures. Can apply force method and finte element			Structures: Understands the dimensioning principles of pile		•	Understands the principles and tools for data and
Understands equivalence of	method in connection with simple bar structure (trucces beams and frames)	S	foundations and can determinate the				product modelling.
force systems and knows principles of force system				nees in piles.			
reduction	Rak-54.1200 Mechanics of Materials for	Rak-11.	.210	07 Bridges and	Foundation		Recognizes the different
Knows principles of equilibrium of a particle and	Structures: Recognises 3-dimensinal state of Stru- strain and Hooke's law		res: , br	: Recognizes th idge parts and	e different types of details.	۲	types of bridges, bridge parts and details.
rigid body							
Knows how to apply particle and equilibrium of a rigid body to determine forces for	Rak-54.1300 introduction to Structural Mechanics: Recognises principles of statially indeterminate structure Can apply force method and finite element method in connection with simple bar structures (trusses, beams ar			<ul> <li>Rak-11.210</li> <li>Foundation</li> <li>Understands</li> <li>principles of</li> </ul>	)/Bridges and 1 Structures: ds the the design of the most genera		Can calculate stress resultants and governing load combinations
pasic stuctures and mechanisms and problems	frames)			bridge types.			
with friction	Rak-54,1300 Introduction to Struc	tural M	1ec	chanics:			
Knows principles of rigid	Recognises principles of statially	indeter	mi	nate	7 Bridges and		
body kinematics, virtual work and potential energy.	al structures. Can apply force method and		finte b		Structures: Can he stressresultants and		Understands the loads on bridges and foundations.
Knows how to apply	structures (trusses, beams and fra	mes)	e	Dat	esigns.		
principles of virtual work and poteltial energy to study equilibrium of a rigid body	Rak-54.2100 Structural Mechanics I: Has the ability to critically analyze beams and frames by applying the theory of elasticity					ł	Knows how to design simple bridges.
-1							
	Rak-54.1300 Introduction to Structural Mechanics: Recognises principles of statially indeterminate structur Can apply force method and finte element method in connection with simple bar structures (trusses, beams an			<ul> <li>Rak-11.210</li> <li>Foundation</li> <li>Understands</li> <li>principles of</li> </ul>	7 Bridges and Structures: s the the design f the most genera		Understands the the design principles of the most common bridge types.

## Courses are scheduled

Tfy-3.1181 Tfy-3.1181	Rak-0.1200 Basic Course in Structural	T-106.1061 T-106.1061	Rak-54.1100 Statics		2005 III spring 24.4
Kul-49.1100 Kul-49.1100	Rak-50.1119 Rak-50.1119	Ene-58.2101 Fundamentals of building	Rak-43.2400 Heat Insulation		2005 IV spring 13.8
T-106.1208 T-106.1208	Mat-1.1332 Mat-1.1332	KE-35.9220 KE-35.9220	Mat-1.2620 Mat-1.2620		2005 summer 6.800000000000000
Mat-1.1410 Mat-1.1410	Mat-1.1420 Mat-1.1420				2005 I fall 8.6
T-106.1111 T-106.1111					2005 II fall 1
S-118.2240 Fundamentals of	Tfy-3.1182 Tfy-3.1182				2006 III spring 8
Rak-54.1200 Mechanics of Meterials for	Rak-82.1111 Concrete Technology 1	Rak-43.1215 Introduction			2006 IV spring 7.2
	Rak-54.3200 Numerical methods in				2006 summer 5
Rak-11.2107 Bridges and Foundation					2006 I fall 4
Structures	Rak-43.3130 Exercise				2006 II fall 5
				Rak-11.3000 Bridges <b>TAPI</b> General	2007 III spring O AUVINEN 4

### Plan can be updated

#### Structural Engineering - Timber Structures

#### Level I

Small one storey wooden buildings. Class C qualification.

#### Provides

- Understand wood as a cellular, orthotropic, hygroscopic, visco-elastic-plastic material, which has natural defects and defects caused by manufacturing.
- Knows the different industrial wood products.
- Tietää puurunkoisten pienten rakennusten (rankarakenteet) suunnittelun ja mitoituksen päävaiheet ja tehtävät sekä menetelmät.
- Ymmärtää naulaliitosten toiminnan, tuntee puikkoliitosten teorian.
- Tietää puurakenteiden asennusprosessin erityisvaatimukset rankarakenteiden kannalta.
- Understand the value of building physics and fire safety in design of timber structures and can estimate the fire resistance of wooden beams and columns.
- Ymmärtää muiden materiaalien roolit liitoksissa.
- Tuntee rankarakenteisiin liittyviä suunnittelu- ja mitoitusohjeita sekä ohjelmistoja.
- Tuntee puurakennusten toteutusasiakirjat, niiden sisällön ja tarkoituksen.
- Osaa käyttää puulle sen rasitustilaa vastaavia lujuus- ja jäykkyysominaisuuksia ja osaa ottaa ajan ja olosuhteiden vaikutuksen huomioon rakenteen suunnitelussa ja mitoituksessa korjauskertoimien avulla.
- Osaa valita toiminnallisia vaatimuksia vastaavat puutuotteet puurakentamiseen.
- Osaa puurunkoisten pienten rakennusten (rankarakenteet) suunnittelun ja mitoituksen.
- Osaa arvioida naulaliitosten kapasiteetin puikkoliitosteorialla ja osaa mitoittaa sen.
- Osaa ottaa huomioon puurakenteiden asennusprosessin erityisvaatimukset rankarakenteiden suunnittelussa.
- Osaa suunnitella rankarakenteen paloteknisesti toimivan rankarakenteen.
- Osaa suunnitella naulaliitoksen.
- Oppii soveltamaan rankarakenteisiin liittyviä ohjeita ja ohjelmistoja.

#### Mandatory prerequisites

Rak-83.2200	Basics of structural design	0.0
<u>Tfy-3.1181</u>	Tfy-3.1181	3.0
<u>Rak-43,1215</u>	Introduction to the design of load-bearing structures	5.0
Rak-54.1300	Introduction to Structural Mechanics	0.0
<u>Tfy-3.1182</u>	Tfy-3.1182	4.0
Rak-43.2100	Basis of structural design I	5.0
T-106.1208	T-106.1208	3.4
Rak-54.2100	Structural Mechanics I	5.0
Mat-1.1410	Mat-1.1410	1.2
Rak-43.3100	Design of load-bearing building frames I	5.0
Rak-82.1106	Building Materials	3.4
Rak-54.2200	Structural Mechanics II	5.0
<u>Kul-49.1100</u>	Kul-49.1100	3.4
<u>Mat-1.1420</u>	Mat-1.1420	3.4
<u>Rak-0,1200</u>	Basic Course in Structural Engineering and Building Technology	5.0
Mat-1.1332	Mat-1.1332	1.0
Rak-11.1201	R-CAD	4.0
KE-35.9220	KE-35.9220	1.2
Rak-54.1100	Statics	5.0
Rak-50.1119	Rak-50.1119	3.4
Rak-54.3200	Numerical methods in structural engineering	5.0
<u>Mat-1.2620</u>	Mat-1.2620	1.2
Rak-11.2107	Bridges and Foundation Structures	4.0
Rak-43.1210	Introduction to Building Physics	5.0
T-106.1111	T-106.1111	1.0
<u>Rak-54.1200</u>	Mechanics of Materials for Structures	0.0
	Total	82.6
	Included in other competences	72.6
	Already passed	0 cr

#### + Add to plan

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## Status

- Work in progress
- Outcome graph done, competences need more work
- Future work: test with students



- Probably a good idea to tie course outcomes to higher-level goals
- Reveals problems in the curriculum
- Constructing an outcome graph is one way

