Course Syllabus

1. **Course Title:** Dynamics of Structures
2. **Course Code:** DYST321917
3. **Credit Units:** 2 (2/0/4) (2 units of theory/ 0 unit of practice/ 4 units of self-study)

   Duration: 15 weeks (2 hours of theory+0 hours of practice, and 4 hours of self-study per week)
4. **Course Instructors**

   1/ Dr. Châu Đình Thành

   2/ MSc. Đoàn Ngọc Tịnh Nghiêm

   3/ Dr. Phan Đức Huynh
5. **Course Requirements**

   Prerequisite courses: None

   Previous courses: Structural Mechanics (STME240517)

   Parallel courses: None
6. **Course Description**

   Students are introduced to concepts of structural dynamics and analysis methods for the linear response of civil engineering structures subjected to time-varying dynamic loads. In details, students will learn how to analyze and formulate the equation of motion of Single Degree-of-Freedom (SDOF) and Multi Degree-of-Freedom System (MDOF) then calculate the dynamic characteristics, displacements, internal forces of these systems. Besides, this course helps students to understand the evaluating of the behaviors of building structures under earthquake ground motions following Vietnam Construction Code.
7. **Course Goals**

Goals	Goal Description	Programme ELOs
G1	Analyze characteristics of structural dynamics	1.3
G2	Solve characteristics and dynamic responses of structural dynamics	2.1, 2.4
G3	Be able to work in group, present and reading English documents	3.1, 3.2, 3.3

8. **Course Learning Outcomes (CLOs)**

CLOs		CLO Description	Programme ELOs
G1	**G1.1**	Analyze dynamic loads and characteristics of structures	1.3
G2	**G2.1**	Establish motion equations of single- and multi-degrees of freedom systems	2.1
	G2.2	Solve dynamic characteristics (frequencies, cycles, mode shapes) and dynamic responses (displacements, velocities, accelerations,	2.1

		moments, shear forces) of structures subjected to dynamic loads	
	G2.3	Study and present methods to compute earthquake loads according to Vietnam codes	2.1, 2.4
G3	**G3.1**	Organize working groups to study and present how to compute earthquake loads	3.1, 3.2
	G3.2	Be able to read lecture nodes and documents in English	3.3

9. Learning Resources

- Textbooks:

1. Anil K. Chopra, *Dynamics of structures: Theory and applications to earthquake engineering*, 3rd Edition, Pearson Prentice Hall, 2007.

- References:

2. Đỗ Kiến Quốc, Lương Văn Hải, *Động lực học kết cấu*, NXB Đại học Quốc gia Tp.HCM, 2010.
3. Phạm Đình Ba, *Bài tập động lực học công trình*, NXB Xây dựng, Hà Nội, 2010.
4. TCVN 9386:2012, Thiết kế công trình chịu động đất, Hà Nội, 2012.
5. Ray W. Clough, Joseph Penzien, Dynamics of Structures, 3rd Edition, Computers & Structures Inc., 2003.
6. Phạm Đình Ba, Nguyễn Tài Trung, *Động lực học công trình*, NXB Xây dựng, Hà Nội, 2009..
7. Bộ Xây dựng – Viện Khoa học Công nghệ Xây dựng, *Hướng dẫn thiết kế kết cấu nhà cao tầng bê tông cốt thép chịu động đất theo TCXDVN 375:2006*, NXB Xây dựng, Hà Nội, 2011.

10. Student Assessment

- Grading scale: **10**
- Assessment plan:

Type	Content	Timeline	Assessment method	CLOs	Rate (%)
Formative assessment					**50**
BT#1	Solve dynamic responses of single-degree of freedom (SDOF) system under hamornic loads	Week 6	Paper test	G1.1, G2.1, G2.2, G3.2	20
BT#2	Solve dynamic responses of multi-degree of freedom (MDOF) system under hamornic loads	Week 13	Paper test	G1.1, G2.1, G2.2, G3.2	20
BT#3	Present methods to compute earthquake loads according to Vietnam codes	Week 15	Presentation	G2.3, G3.1	10
Summative assessment					**50**
	- Solve dynamic characteristics and responses of SDOF and MDOF systems - Duration: 60 minutes		Paper test	G2.1, G2.2	

11. Course Content

Week	Content	CLOs
1	*Chapter 1:* **Overview**	

	A/ Content and pedagogical methods in class*: (2h)*
	
	Introduce goals, CLOs, content, teaching and learning methods, and assessment methods of the course
	
	Content:
	  1.1 Fundamental objective of structural dynamic analysis
	  1.2 Types of prescribed loadings
	  1.3 Essential characteristics of a dynamic problem
	  1.4 Lumped-mass method of discretization
	  1.5 Formulation of the equations of motion
	
	Pedagogical methods:
	  + Presentation of lecture
		G1.1, G3.2

	B/ Self-study content: *(4h)* Stydy different types of dynamic loads applying on structures, especially building structures Review how to compute displacements of a determinate and indeterminate structure subjected to static loads	G1.1, G2.1
2	*Chapter 2:* **Single-degree-of-freedom (SDOF) systems**	

	A/ Content and pedagogical methods in class*: (2h)*
	
	Content:
	  2.1 Equations of motion
	      2.1.1 Simple structures
	      2.1.2 Single-degree-of-freedom system
	      2.1.3 Force – displacement relation
	      2.1.4 Damping force
	      2.1.5 Equation of motion: External force
	      2.1.6 Influence of gravitational forces
	      2.1.7 Equation of motion: Earthquake excitation
	
	Pedagogical methods:
	  + Presentation of lecture
	  + Solve examples
		G2.1, G3.2

	B/ Self-study content: *(4h)* Do homework Review how to solve second order differential equations with constant coefficients	G2.1, G2.2
3	*Chapter 2:* **Single-degree-of-freedom (SDOF) systems** *(cont.)*	

	A/ Content and pedagogical methods in class*: (2h)*
	Content:
	  2.2 Undamped free vibration
	  2.3 Viscously damped free vibration
	      2.3.1 Types of motion
	      2.3.2 Underdamped system
		G1.1, G2.2, G3.2

	2.3.3 Decay of motion 2.3.4 Free vibration tests **Pedagogical methods**: + Presentation of lecture + Solve examples	
	B/ Self-study content: *(4h)* Do homework Research damping systems that are used in construction to reduce earthquake damages	G1.1, G2.2
4	*Chapter 2:* **Single-degree-of-freedom (SDOF) systems** *(cont.)*	

	A/ Content and pedagogical methods in class*: (2h)*
	Content:
	  2.4 Harmonic vibration of undamped systems
	      2.4.1 Hormonic forces
	      2.4.2 Vibration of undamped systems due to sine force
	      2.4.3 Dynamic response factors
	      2.4.4 Resonant phenomenon
	Pedagogical methods:
	+ Presentation of lecture
	+ Solve examples
		G2.2

	B/ Self-study content: *(4h)* Derive solution of vibration of undamped SDOF system due to cosine load Do homework	G2.2
5	*Chapter 2:* **Single-degree-of-freedom (SDOF) systems** *(cont.)*	

	A/ Content and pedagogical methods in class*: (2h)*
	Content:
	  2.5 Harmonic vibration with viscous damping
	      2.5.1 Vibration of viscously damped systems due to sine force
	      2.5.2 Resonant phenomenon
	      2.5.3 Dynamic response factors
	Pedagogical methods:
	+ Presentation of lecture
	+ Solve homework and discuss
		G2.2

	B/ Self-study content: *(4h)* Derive solution of vibration of underdamped SDOF system due to cosine load Do homework	G2.2
6	*Chapter 3:* **Multi-degree-of-freedom (MDOF) systems**	

	A/ Content and pedagogical methods in class*: (2h)*
	Content:
	  3.1 Simple system: two-story shear building
	      3.1.1 Equations of motion
	      3.1.2 Mass – spring – damper system
	Pedagogical methods:
		G2.1, G3.2

	+ Presentation of lecture	
	B/ Self-study content: *(4h)* Review how to solve displacements due to forces and reactions due to diaplacements of constrains	G2.2
7	*Chapter 3:* **Multi-degree-of-freedom (MDOF) systems** *(cont.)*	

	A/ Content and pedagogical methods in class: *(2h)*
	 Content:
	   3.2 Equations of motion for MDOF systems
	     3.2.1 Discretization
	     3.2.2 Elastic forces: Stiffness, Flexibility
	     3.2.3 Damping forces
	     3.2.4 Inertia forces
	     3.2.5 Equations of motion: External forces
	     3.2.6 Equations of motion: Translational ground motion
	 Pedagogical methods:
	   + Presentation of lecture
	   + Solve examples
		G2.1, G3.2

	B/ Self-study content: *(4h)*
	   Do homework
	   Review how to solve algebraic linear system $\mathbf{Ax} = \mathbf{0}$
		G2.1, G2.2

8	*Chapter 3:* **Multi-degree-of-freedom (MDOF) systems** *(cont.)*	

	A/ Content and pedagogical methods in class: *(2h)*
	 Content:
	   3.3 Natural vibration frequencies and modes
	     3.3.1 Free vibration of MDOF systems without damping
	     3.3.2 Natural vibration frequencies and modes
	 Pedagogical methods:
	   + Presentation of lecture
		G1.1, G2.2, G3.2

	B/ Self-study content: *(4h)* Do homework	G2.2
9	*Chapter 3:* **Multi-degree-of-freedom (MDOF) systems** *(cont.)*	

	A/ Content and pedagogical methods in class: *(2h)*
	 Content:
	   3.3 Natural vibration frequencies and modes *(cont.)*
	     3.3.3 Orthogonality of modes
	 Pedagogical methods:
	   + Presentation of lecture
	   + Solve examples
		G2.2

	B/ Self-study content: *(4h)* Prove the orthogonality of modes and self-study normalization of modes	G2.2
10	*Chapter 3:* **Multi-degree-of-freedom (MDOF) systems** *(cont.)*	

	A/ Content and pedagogical methods in class: *(2h)*	G2.2
	Content:	
	3.4 Free vibration of undamped MDOF systems	
	Pedagogical methods:	
	+ Presentation of lecture	
	+ Solve examples	
	B/ Self-study content: *(4h)* Do homework	G2.2
11	*Chapter 3:* **Multi-degree-of-freedom (MDOF) systems** *(cont.)*	
	A/ Content and pedagogical methods in class: *(2h)*	G2.2
	Content:	
	3.5 Free vibration of damped MDOF systems	
	3.5.1 Classically and non-classically damped systems 3.5.2 Free vibration of classically damped MDOF systems	
	Pedagogical methods:	
	+ Presentation of lecture	
	+ Solve examples	
	B/ Self-study content: *(4h)* Do homework	G2.2
12	*Chapter 3:* **Multi-degree-of-freedom (MDOF) systems** *(cont.)*	
	A/ Content and pedagogical methods in class: *(2h)*	G2.2
	Content:	
	3.6 Forced vibration response of MDOF system	
	Pedagogical methods:	
	+ Presentation of lecture	
	+ Solve homework and discuss	
	B/ Self-study content: *(4h)* Do homework Study meanings of choosing number of modes in the method of superposition of mode shapes	G2.2, G2.3
13	*Chapter 4:* **Earthquake response of structures**	
	A/ Content and pedagogical methods in class: *(2h)*	G1.1, G2.2, G3.2
	Content:	
	4.1 Earthquake excitation	
	4.2 Earthquake response of SDOF systems	

	4.2.1 Equation of motion due to earthquake excitation
	    4.2.2 Time – history responses
	    4.2.3 Elastic response spectrum of displacements, pseudo-velocity and pseudo-acceleration	

	Pedagogical methods:	
	+ Presentation of lecture	
	+ Discuss	
	B/ Self-study content: *(4h)* Study Elastic response spectrum according to Vietnam codes	G1.1, G2.3

14	*Chapter 4:* **Earthquake response of structures** *(cont.)*		

	A/ Content and pedagogical methods in class: *(2h)*
	 Content:
	   4.3 Earthquake response of MDOF systems
	      4.3.1 Equation of motion due to earthquake excitation
	      4.3.2 Time – history responses
	      4.3.3 Analysis of response spectrum
	 Pedagogical methods:
	   + Presentation of lecture
	   + Discuss
		G2.2, G3.2

	B/ Self-study content: *(4h)* Group homework: Prepare presentation of how to compute earthquake loads on structures according to Vietnam codes	G2.3, G3.1
15	*Chapter 4:* **Earthquake response of structures** *(cont.)*		

	A/ Content and pedagogical methods in class: *(2h)*
	 Content:
	   4.4 Determine earthquake loads applying on MDOF systems according to Vietnam code
	      4.4.1 Lateral force method of analysis
	      4.4.2 Modal response spectrum analysis
	 Pedagogical methods:
	   + Students present the methods and discuss in group
		G2.2, G2.3, G3.1

	B/ Self-study content: *(4h)* Review and prepare for final exam	

12. Learning Ethics

Students must do homework and presentation by themselves. If plagiarism is found students will get zero point.

13. Date of first approval: August 1st, 2012

14. Approved by

Dean	Head of Department	Instructor
A/Prof. Dr. Nguyễn Trung Kiên	**MSc. Nguyễn Văn Hậu**	**Dr. Châu Đình Thành**

15. Date and Up-to-date content

1st **time:** Date:	Instructor:
	Head of Department: