NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF CIVIL ENGINEERING

CIVIL ENGINEERING PROGRAM

SYLLABUS – BRIDGES AND ART WORKS

I. GENERAL INFORMATION

CODE	**:**	EC323
SEMESTER	**:**	9
CREDITS	**:**	3
HOURS PER WEEK	**:**	**5** (Theory – Practice)
PREREQUISITES	**:**	EC211 Structural Analysis I, EC311 Reinforced Concrete I
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Structures
INSTRUCTOR	**:**	Victor Sanchez, Cesar Aranis, Mario Mamani
INSTRUCTOR E-MAIL	**:**	vsmoya@hotmail.com

II. COURSE DESCRIPTION

The course prepares students for the structural analysis and design of commonly used bridges with their main structural components. Students should complete the structural design of a bridge including construction specifications as well as present and defend a report containing drawing sheets and detailed explanation of the complete design process.
Students should understand and apply AASHTO LFRD norms and its correspondence with the National Norms and Regulation on weight and dimensions of heavy vehicles. The course includes a revision of beam design theory and it application to the modeling and analysis of the bridge superstructure using approximate AASHTO methods and specialized software such as SAP 2000. For designing, the instructor also presents AASHTO LFRD applications for designing bridges with reinforced concrete, post-tensed concrete, metal beams and metal reticulates.

III. COURSE OUTCOMES

1. Analyze and interpret the outcomes of the project Basic Studies to propose the characteristics and structural typology of the bridge.
2. Propose bridges alternatives and assess them technically and economically considering construction processes, functionality, and construction costs based on a pre-dimensioning of the main components of the bridge superstructure and substructure.
3. Model and analyze the bridge board structure using AASHTO LFRD methods, influence line methods and SAP 2000 for computing the envelope of maximum shear stress and moments
4. Design to flexion and shear stress limits the bridge components using AASHTO LFRD methodology for service and resistance limit states. It includes beams, columns, connectors, slab, foundation and support devices,
5. Elaborate drawing sheets of a bridge with construction specifications.
6. Elaborate technical reports detailing design process, metrics, specifications, unitary costs and budget.

IV. LEARNING UNITS

1. BRIDGES FUNDAMENTALS

Structural components / Structural typologies / National bridges inventory / Bridge engineering in Peru and the world / Bridge management systems

2. BASIC STUDIES AND ELABORATION OF THE TECHNICAL REPORT FOR BRIDGE DESIGN AND CONSTRUCTION

Topographical analysis / Hydrology and hydraulic analysis / Geological and geotechnical analysis / Seismic risk analysis / Technical report: contents and scope / Construction specifications / Dimensioning / Unitary costs and budget / Civil works programming.

3. SPECIFICATIONS, NORMS AND REGULATIONS

AASHTO LRFD technical specifications for bridges design and assessment / Limit states / National Vehicle Regulation / Loads and overloads for designing.

4. STRUCTURAL MODELING AND ANALYSIS OF BRIDGE SUPERSTRUCTURE

Beam theory / Beam influence lines / Structural modeling and analysis using SAP 2000 and CSI Bridge.

5. DESIGN OF BRIDGE COMPONENTS (BEAMS, COLUMNS, SLAB) USING REINFORCED CONCRETE AND POST-TENSED CONCRETE ACCORDING TO AASHTO LFRD

Design of slabs by flexion in principal and secondary directions / Empirical methods for slab design / Flexion design of reinforced concrete beams / Flexion design of post-tensed concrete beams in service I and III and in resistance I / Shear design of post-tensed concrete beams / Verification of resistance limit states / Shear connectors.

6. FOUNDATIONS AND SUPPORT

Support types and classification / Design of metal supports, concrete supports / Support structures and stirrup / Earthquakes effects / Mononobe-Okabe theory / Surface foundations design / Global stability / Slipping resistance / Permissible eccentricities / Deep foundations / Caissons and pilings.

V. METHODOLOGY

In the first half of the academic semester the instructor presents and analyzes the main aspects and considerations for bridge design. Specialized faculty is invited to present themes on hydrology and hydraulics, geology and geotechnics and construction process required for bridge design. In the second half of the semester, students are grouped in teams to carry out and complete the design of a bridge required in some place in the country. A detailed project report should be submitted and defended.

VI. EVALUATION FORMULA

The average grade PF is calculated as follows:

PF = 0.25 EP + 0.25 EF + 0.50 TE

EP:	Mid-Term Exam	EF:	Final Exam
PP:	Average of two quizzes	TE:	Design project report

VIII. BIBLIOGRAPHY

1. AASHTO DESIGN TECHNICAL SPECIFICATIONS, 2010.

2. Richard M. Barker, Jay A. Puckett
DESIGN OF HIGHWAY BRIDGES: AN LRFD APPROACH, 2007

3. THE MANUAL FOR BRIDGE EVALUATION AND INSPECTION, AASHTO
Second Edition, 2010.

4. MANUAL OF BRIDGE DESIGN
Transportation and Communications Department, Lima, Peru.

IX. COURSE CONTRIBUTIONS TO STUDENT OUTCOMES ATTAINMENT

Course contributions to Student Outcomes are shown in the following table:

K = Key **R** = Related **Empty box** = Does not apply

	Outcome	Contribution
Engineering Design	Design civil works satisfying requirements and needs as well as given constraints and limitations.	**K**
Problem solving	Identify, formulate and solve engineering problems properly using the methods, techniques and tools of civil engineering.	**K**
Sciences Application	Apply the knowledge and skills of mathematics, sciences and engineering to solve civil engineering problems.	**K**
Experimentation	Conceive and conduct experiments, analyze data and interpret results	**R**
Modern Engineering	Use and apply techniques, methods and tools of modern engineering necessary for the practice of civil engineering.	**K**
Engineering Impact	Understand the impact of engineering solutions on people and society in local and global contexts.	**K**
Project Management	Plan and manage civil engineering projects taking into account efficiency and productivity criteria.	**K**
Environmental Appraisal	Takes into account the importance of preserving and improving the environment in the development of their personal and professional activities.	**K**
Lifelong Learning	Recognize the need to keep their knowledge and skills up to date according to advances of civil engineering and engage in lifelong learning.	**K**
Contemporary Issues	Know and analyze relevant contemporary issues in local, national and global contexts.	**K**
Ethics and Professional Responsibility	Evaluate their decisions and actions from a moral perspective and assume responsibility for the executed projects.	**K**
Communication	Communicate clearly and effectively in oral, written and graphical formats, interacting with different types of audiences.	**K**
Teamworking	Appraise the importance of teamworking and participate actively and effectively in multidisciplinary teams.	**K**