The Curriculum Reform of the Civil Engineering Undergraduate Course at UNICAMP

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Abstract *— The civil engineers graduated by FEC-UNICAMP will receive a solid scientific, technological, humanistic, and cultural background to qualify them to fully develop their careers in either technical or management occupations, along with creativity, cooperative working attitude towards teamwork, permanent professional update, commitment to the use of techniques in compliance with the transformations occurred in Brazil, and critical sense about the effects caused by the engineering solutions within both social and environmental contexts.*

Index Terms *— Curriculum reform.*

PRINCIPLES AND GUIDELINES FOR THE EDUCATION OF FEC-GRADUATED CIVIL ENGINEERS

The curriculum currently in force at FEC defines its objective as "*Educating a Full Civil Engineer with solid scientific as well as technological background, who is able to take action at any domain of Civil Engineering by commanding, developing, and generating technology*". Despite the wide, comprehensive range proposed by such definition, it is worth revising it in the sight of the present context.

A first aspect to be taken into account refers to the provisions of the National Curricular Guidelines for Engineering Courses (Resolution No. 11 of the Brazilian National Educational Board/Chamber of Higher Education, 03/11/2002), which is transcribed next.

Article 3 – The profile of the graduating students/professionals from the Undergraduate Engineering Course is the one of engineers holding a generalist, humanist, critical, and reflective background, who are able to absorb and develop new technologies, stimulating their thoughtful and creative action over the identification and resolution of problems, considering their political, economic, social, environmental, and cultural aspects through an ethical as well as humanistic view to meet social demands.

Article 4 – The education of engineers is aimed at empowering the professional with the knowledge required to exert the following general competences and abilities:

I -	*applying mathematical, scientific, technological, and instrumental knowledge concerned with engineering;*
II -	*designing and performing experiments as well as interpreting the results;*
III -	*conceiving, designing, and analyzing systems, products, and processes;*
IV -	*planning, supervising, elaborating, and coordinating engineering projects and services; ;*
V -	*identifying, formulating, and solving engineering-related problems; ;*
VI -	*developing and/or utilizing new tools and techniques;*
VI -	*supervising system operation and maintenance;*
VII -	*thoughtful evaluation of system operation and maintenance;*
VIII -	*communicating effectively through written, verbal, and graphic means;*
IX -	*acting in multidisciplinary teams;*
X -	*understanding and applying professional responsibility ethics; ;*

XI - assessing the impact caused by engineering activities upon both social and environmental contexts;
XII - assessing economic feasibility for engineering projects;
XIII - assuming the attitude of permanent search for professional refurbishing.

Article 5 – Each Engineering course is supposed to have a pedagogical project that states clearly how the group of activities will guarantee the desired profile of the student who has concluded the course and the development of the expected competences and abilities. Emphasis should be given to the necessity of reducing the time spent on in-class activities, encouraging both individual as well as teamwork.

§ 1 Synthesis work and activities promoting the integration of knowledge acquired during the course should be a reality and at least one of them should be considered as a mandatory activity taken as a requirement to achieve graduation.

§ 2 Complementary activities should also be stimulated, such as Undergraduate Research, multidisciplinary projects, theoretical field trips, teamwork, prototype development, tutoring services, participation in junior companies, and other enterprising activities.

In addition to these legal references, it is also worth presenting the principles established for FEC as shown in the Strategic Planning (PLANES, 2004):

- Excellence criteria in teaching, research, and extension proceedings;
- Insertion of research into teaching;
- Autonomy and intellectual freedom;
- Scope of action comprising the manifold Brazilian as well as Latin-American urban realities, though respecting communities and lack of resources in those societies;
- Respect to sociodiversity;
- Technological innovation aimed at social inclusion.

For specific educational purposes, PLANES-FEC defines as its goal the guidance of professionals:

- holding high technical qualification, prepared for the acquisition of new scientific knowledge, social transformations and globalization;
- who act as policy makers and entrepreneurs, holding a global view of society and respective problems;
- from the city, promoting sociodiversity with quality of life through transversality concerned with the knowledge of elementary, humanistic, and technological sciences.

Based on theoretical references, as set forth by the curricular guidelines and by PLANES-FEC, suggested guidelines for the education of civil engineers through the new curriculum are presented next:

> *The civil engineers graduated by FEC-UNICAMP will receive a solid scientific, technological, humanistic, and cultural background to qualify them to fully develop their careers in either technical or management occupations, along with creativity, cooperative working attitude towards teamwork, permanent professional update, commitment to the use of techniques in compliance with the transformations occurred in Brazil, and critical sense about the effects caused by the engineering solutions within both social and environmental contexts.*

As stressed before (Figure 2), the definition of objectives in the educational process will be the guideline of several other decisions to be made throughout the curriculum reform process. Therefore, it fell to FEC professors to actively participate in the discussion about the pertinence and adequacy of the suggested educational guidelines exposed by this document so that its development is permitted as well as the continuity of the curriculum reformulation process.

PRELIMINARY ISSUES

Civil Engineering has experienced major changes due to improvements that have taken place in the last decades, mainly owing to the increasing use of computers, the development of new materials and technologies, the adoption of new

analytical methods, the concern about environmental issues, and the gradually increasing presence of civil engineers in activities such as planning, administration, and management. This has led to the diversification and enhancement of the scope of action regarding the Civil Engineer, inasmuch as to create profiles that differ from the traditional areas, which in our college comprise: structures, geotechnics and transport, sanitation and environment, water resources, and building construction.
In its Resolution CNE/CES 11, issued on MARCH 11, 2002, the NATIONAL BOARD OF EDUCATION established the CURRICULUM GUIDELINES FOR ENGINEERING COURSES, in which it is possible to highlight two essential elements contained within the new definition of curriculum:
1. Emphasizing the set of learning experiences. Therefore, the notion of Curriculum goes far beyond the idea of conventional classroom activities, so complementary activities must be taken into account, such as Undergraduate Scientific and Technological Research, comprehensive academic programs, extension programs, technical field trips, scientific events, in addition to cultural, political, and social activities, among others, which are developed by the students during their undergraduate course. Such complementary activities are aimed at broadening the horizons of a given professional guidance, leading to a more comprehensive sociocultural education.
2. Explicating the concept of participative process through understanding that learning can only be consolidated if students play an active role to build their own knowledge and expertise accompanied by the professor's guidance and participation.

One can also perceive new tendencies that point towards undergraduate courses under more flexible structures. A meaningful link between theory and practice is noticed, a clear concern about human being values, environment preservation and the social as well as political integration of professionals, which leads to the possibility of direct articulation with graduate studies.

In order to stay close to these issues, FEC struggled to update the undergraduate Civil Engineering curriculum as well as the related teaching methodologies.
Such update is supposed to be continued to provide our students with a solid and comprehensive education, in addition to preparing them to take action within their manifold professional segments (project, administration and management, construction, planning, research and development of new technologies, methods and processes).

An ideal curriculum should present, among others, the following features: (a) coverage, to guarantee full guidance in the area; (b) lightness, so students do not feel suffocating due to an overflow of course disciplines and a load of credit hours that surpasses their assimilation capacity; (c) flexibility, to allow the introduction/withdrawal of contents with no need to take everything apart; (d) adequacy and pertinence in relation to the objectives of the intended guidance; (e) content update and implementation possibility by using reasonable didactics and pedagogical practices. The diverse attempts to promote curriculum reforms in both national and international engineering courses have disclosed the complexity and the dimension meant by the challenge to find good curricular models.

PROPOSAL

After having analyzed the proposals stemming from the Departments, the Curriculum Reform Committee considered the following curriculum reform assumptions as yearnings of the community:

a) change from the pedagogical model that has been adopted so far, which is almost exclusively based on on-site classes, into a model according to which the teaching/learning strategy takes students capacity into account to study a few program contents without the professor's direct intervention, thus reducing the number of credit hours inside the classroom.
b) Establishment of the Advisory concept by means of implementing a teaching strategy in which the practical side or the accomplishment of projects at some course disciplines is supervised by tutorial professors
c) Establishment of a COMMON STANDARD complemented by EMPHASES, a mandatory supervised research program amounting to 180 hours and an integrated project – a course completion project.
d) Establishment of concrete conditions for students willing to enter the Integrated Formation Program (the so-called "PIF Program"), in order to anticipate their master program.
e) Establishment of a Credit Transfer Program for the cases in which a part of course disciplines belonging to a given EMPHASIS might have been attended abroad.

In an attempt to make the above mentioned postulates feasible, the common standard should be completed within the eight first semesters for the proposal that is hereby presented. The last two semesters will be reserved for mandatory as well as elective disciplines concerned with the EMPHASES in order to engage in the mandatory supervised research program and get prepared for the course completion project.
Students who are interested in enrolling in the PIF Program at the end of the course should mandatorily get involved with Undergraduate Research Projects. In order to obtain free space in the curriculum framework to start PIF Program course disciplines, after having achieved a progression coefficient higher than 0.75, these students should plan their framework so that a part of elective disciplines are attended as early as possible.

Students may also opt for an international supervised research program with a predefined credit transfer program so that, as they return, only the credits to fulfill a given EMPHASIS are required for course completion.

COMMON STANDARD CURRICULUM FRAMEWORK

SEMESTER 01									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
MA111	us I							06	IMECC
MA141	ical Geometry and Vectors							04	IMECC
MC102	hms and Computer Programming							06	IC
CV141	stry for Civil Engineering	02			01			03	FEC-DSA
QG102	mental Chemistry I							04	IQ
CV101	tive Drawing	01	02					03	FEC-DAC
CV151	uction to Civil Engineering	02						02	FEC-CG
	Total credit hours in the semester							28	

SEMESTER 02									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
MA211	us II							06	IMECC
ME203	ntary Statistics							04	IMECC
F128	l Physics I							04	IFGW
F129	mental Physics I							02	IFGW
GM420	l Geology	04			01			05	IG
CV201	ter-Aided Design	02			01			03	FEC-DAC
CV202	g Construction Materials I	02		01				03	FEC-DAC
CV211	ural Systems	01		01	01			03	FEC-DES
	Total credit hours in the semester							30	

SEMESTER 03									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
CV311	us for Civil Engineering	04			02			06	FEC-DES
MS211	ical Calculus							04	IMECC
CV301	s for Civil Engineering	04						04	FEC-DAC
F229	mental Physics II							02	IFGW
CV312	l Mechanics	03						03	FEC-DES
CV332	g Construction Materials II	02		01				03	FEC-DAC
CV351	uction to Economics	02						02	FEC-DAC/IE
CV321	raphy and Geodesy I	01	02					03	FEC-DGT
	redit hours in the semester							27	

SEMESTER 04									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
F328	l Physics III							04	IFGW
F329	mental Physics III							02	IFGW
CV401	istration Applied to the Construction rise	02						02	FEC-DAC
CV402	ecture Project	01	02					03	FEC-DAC
CV431	Mechanics	04		01				05	FEC-DRH
CV411	Mechanics I	05			01			06	FEC-DES
CV421	raphy and Geodesy II	01	01	01				03	FEC-DGT
CV422	uction to Operational Research	01	01					02	FEC-DGT
CV450	fic Methodology and Scientific Essay W	02						02	
	redit hours in the semester							29	

SEMESTER 05									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
CV501	Planning	01	02					03	FEC-DAC
CV531	ulic Engineering	04		01				05	FEC-DRH
CV522	ort Technique	01	01					02	FEC-DGT
CV511	Mechanics II	05			01			06	FEC-DES
CV521	hnics I	02	01					03	FEC-DGT
CV532	technics and Power	02		01				03	FEC-DRH
CV541	nment Sanitary Quality	03		01	01			05	FEC-DSA
Elective		03						03	
	Total credit hours in the semester							30	

SEMESTER 06									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
CV612	of Structures I							04	FEC-DES
CV641	Supply Systems							04	FEC-DSA
CV631	cal Systems for Buildings							03	FEC-DRH
CV621	hnics II							03	FEC-DGT
CV622	ay I							04	FEC-DGT
CV632	Hydrology							04	FEC-DRH
CV613	n Structures							03	FEC-DES
Elective								03	
CV633	g Techniques I							03	FEC-DAC
	redit hours in the semester							31	

SEMESTER 07									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
CV721	ations	02	01		01			04	FEC-DGT
CV713	Structures I							04	FEC-DES
CV714	rced Concrete Structures I							06	FEC-DES
CV712	of Structures II	04			01			05	FEC-DES
CV741	ge Systems: Sanitary and Stormwat	03	01		02			06	FEC-DSA
CV701	rise Planning and Control	02		02				04	FEC-DAC
CV722	ays II	02						02	FEC-DGT
CV702	g Systems, Hydraulic/Sanitary Syst s I	01		02				03	FEC-DAC
	redit hours in the semester							34	

SEMESTER 08									
ACRONYM	DISCIPLINES	CREDITS							Accountability
		T	P	L	O	E	SL	C	
CV811	rced Concrete Structures I	01	01		01			03	FEC-DES
CV813	Structures II	02	01		01			04	FEC-DES
CV812	Structures	01	01		01			03	FEC-DES
CV841	y Applied to Civil Engineerin	03			01			04	FEC-DSA
CV821	ort Economics	01	01					02	FEC-DGT
CV831	ngineering Regulations	02						02	FEC-DRH
CV823	ts	01	01					02	FEC-DGT
CV814	rced Concrete Structures II	03	02		01			06	FEC-DES
CV832	Rivers and Canals	02						02	FEC-DRH
CV822	ays III	02						02	
Elective		04						04	
	tal credit hours in the semest							34	

EMPHASES

Each student is supposed to choose a unique Emphasis to conclude the Civil Engineering course. Completing the chosen Emphasis requires students to go through 15 mandatory credits in the Emphasis, 12 elective credits chosen from a set of disciplines related to the emphasis at issue, and 9 further elective credits outside the chosen emphasis.
After graduation, students willing to fulfill the demands of another emphasis may return to FEC. After having met the related requirements, they will be entitled to receive a specific certificate from that activity.

It is important to highlight the fact that, although the elective credits are previously intended by the suggestion grid for both ninth and tenth semesters, students may register for those courses beforehand, and complete them along with common standard disciplines as soon as the prerequisites to such courses have been attained.

The following are the 5 emphases available:

Emphasis on Structure Engineering - The Structure Department is responsible for the Emphasis on Structures and Foundations of Unicamp's Civil Engineering Course. It is aimed at educating professionals who are able to elaborate and/or inspect projects by taking care of the conception, arrangement, and dimensioning of parts and distribution of the required efforts for the elements of civil construction: buildings, bridges, towers, water reservoirs, etc;

Emphasis on Construction Project Management – The emphasis on Construction & Project Management, which relies on the participation of the Department of Academic Affairs and is aimed at complementing the Civil Engineering education so that students are ready to act in all the generation stages of a building construction enterprise, from its conception (study of the requirement program) through its project and execution up to the usage, operation, and maintenance phases.

Emphasis on Transport and Geotechnics – The emphasis on Transports and Geotechnics comprises the study of conception criteria and project methods for the implementation of traffic undertakings such as highways, urban roads, railroads and airdromes, involving geometric and geotechnic project aspects as well as the planning and the operation of logistic and transport systems encompassing urban and intercity transport issues, logistics, load and passenger traffic, in addition to a profound guidance in geomatics, with emphasis on Geographic Information Systems. All this in association with a complementation in the area of Geotechnics, which goes deeper in themes developed within the common standard, such as special foundations project and environmental aspects concerned with geotechnic construction.

Emphasis on Water Resources Management – In the area of Water Resources, students will be strengthening their education by studying floods, average design flow in small basins, hydroelectric development, pumps, pumping stations, and other connected themes.

Emphasis on Environmental Sanitation – The Environmental Sanitation area allows students to enrich their education through analytical techniques for water quality control, environmental planning and analysis of impacts on civil constructions, dimension of units for water treatment, waste waters and residues.

Table for the distribution of credit hours concerned with a given emphasis

SEMESTERS 9 and 10 - Emphasis on a given area					
ACRONYM	DISCIPLINES	CREDITS			Accountability
				C	
EC915	ised Research Program (180 hours)			12	CG-FEC
EC940	ated Project			06	CG-FEC
several	datory credits for disciplines in the Emp			15	ment responsible for the em
several	tive credits in the Emphasis			12	ment responsible for the em
several	ve credits outside the Emphasis			09	other departments
Average total credits/week in the two semesters				21	

REFERENCES

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